FACULDADE DE ARQUITETURA
UNIVERSIDADE DE LISBOA

IMAGINE A SHARED FUTURE

A Sustainable Car Sharing Concept for Greater Lisbon

PRELIMINARY DOCUMENT

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Abstract

Individual mobility – not only expression of human need, but also a prerequisite for the functional and economic capability of today's society. The spatial mobility and, subsequently, the choice of a transport mode is of central significance in this respect. The passenger transport in European cities, such as Lisbon, is nowadays still characterized by a predominance of automobiles, for reasons of constant availability and high flexibility. Closely connected thereby are numerous negative ecological, economic and social side effects, such as noise pollution, land use, traffic accidents, air pollutant emissions and not least the emissions of harmful greenhouse gases. To counteract these negative consequences of increasing traffic, sustainable mobility concepts, closely linked to sustainable development, have to shift more and more into the focus of public interest. The property-less car use, the so-called car sharing could offer a highly promising approach while preserving the individual mobility.

To depict a positive contribution for an increasingly sustainable and innovative environment in Lisbon, a sustainable car sharing concept has been designed within the scope of this master dissertation. A product-service system was designed according to a holistic environmentally friendly product development process with the aim to reduce air pollution, noise and traffic caused by transportation in the city. To solve the question, whether a car sharing concept can be a sustainable solution for the increasing traffic problems in Greater Lisbon, a mixed qualitative methodology was used. On the basis of the evaluation of current literature and surveys by interviews, the theoretical contextualization has been discussed for a deeper understanding of the importance of a sustainable car sharing concept. Case study analysis of existing product-service

systems also constituted as a complementary source of information. Based on the developed concept, a qualitative interventional methodology, the active research, furthermore contributed in replying to the research question.

Key words: Sustainability; Sustainable Development; Car Sharing; Greater Lisbon

Resumo

Mobilidade individual – não só é uma manifestação da necessidade humana, como também é um pré-requisito para a capacidade funcional e econômica da sociedade atual. A mobilidade espacial, e posteriormente, a escolha de um meio de transporte, é de importância fundamental no que se diz a este respeito. O transporte de passageiros nas cidades europeias, como Lisboa, é atualmente ainda caracterizada pela predominância de automóveis, por motivos de disponibilidade constante e alta flexibilidade. Deste modo, estreitamente relacionados estão os inúmeros impactos ecológicos, econômicos e sociais, como poluição sonora, uso da terra, emissão de poluentes atmosféricos e, não menos importante, as emissões de gases de efeito estufa nocivos. Para neutralizar essas consequências negativas do aumento de tráfego, conceitos de mobilidade sustentável, estreitamente ligados ao desenvolvimento sustentável, precisam mudar mais ainda para o foco de interesse público. Carros de autosserviço, ou car sharing, podem oferecer uma abordagem altamente promissora, e ainda assim preservar a mobilidade individual.

Para retratar uma contribuição positiva para um ambiente cada vez mais sustentável e inovador em Lisboa, um conceito de car sharing sustentável foi criado no âmbito da dissertação de mestrado. Um sistema de produto/serviço foi criado de acordo com um processo de desenvolvimento de produto ecológico holístico, com o objetivo de reduzir a poluição atmosférica, barulho e tráfego, causados pelo transporte na cidade. Para resolver a questão se um conceito de car sharing pode ser uma solução sustentável para o aumento de problemas do tráfego na Grande Lisboa, uma metodologia qualitativa mista foi usada. Com base em uma análise da literatura atual e pesquisas por entrevistas, a contextualização

teórica foi discutida para uma compreensão mais profunda sobre a importância de um conceito sustentável de car sharing. Análise de estudo de caso de sistemas de produtos/serviços existentes também foi constituido como uma fonte de informação complementar. Além disso, baseado no conceito desenvolvido, uma metodologia qualitativa interventiva, a investigação ativa, contribui para a resolução da pergunta de pesquisa.

Palavras-chaves: Sustentabilidade; Desenvolvimento sustentável; Car Sharing; Grande Lisboa

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List of Abbreviations

AMTL	Autoridade Metropolitana de Transportes de Lisboa
B2C	Business to Consumer
BUND	Bund für Umwelt und Naturschutz Deutschland
CO_2	Carbon Dioxide
C2C	Cradle-to-Cradle
DFKI	Deutsches Forschungszentrum für Künstliche Intelligenz
EEA	European Environment Agency
EMEL	Empresa Municipal de Mobilidade e Estacionamento de Lisboa
EPA	Environmental Protection Agency
EU	European Union
F_{AERO}	Aerodynamic Forces
F_{FR}	Friction Forces
F_{GRAV}	Gravitation Forces
$F_{INERTIA}$	Inertia Forces
F_{RR}	Rolling Resistance Forces
INE	Instituto Nacional de Estadistica
NFC	Near Field Communication
NO_2	Nitrogen dioxide
NFP	Not for Profit

PM10	Fine Dust
PSS	Product-Service-System
P2P	Peer to Peer
RFID	Radio-frequency Identification
UN	United Nations
UNCED	United Nations Conference on Environment and Development

Chapter I

Introduction

1 Introductory Note

"One of the big challenges of the 21st century will be to mitigate the negative effects of transport – greenhouse gases, air pollution and noise – while ensuring positive aspects of mobility."

- Jacqueline McGlade, former executive director of the European Environment Agency (EEA) (2012) –

A growing size of the world's population and increasing prosperity in conjunction with the tendency towards urbanization led to an over-proportioned number of vehicles in cities and metropolitan areas all around the globe. Different circumstances such as the jumble of narrow streets, often found in Southern European countries, intensify the problems with road congestion and a lack of parking spaces.

The passenger transport in Portugal is nowadays predominantly characterized by passenger cars, which is owed to the constant availability and independence at predetermined times and routes. What from the user's perspective, however, represents the most convenient way of getting around, is accompanied by numerous negative environmental, economic and social side effects such as noise pollution, land use, traffic accidents, resource scarcity, air pollutant emissions and not least the emissions of harmful greenhouse gases are just some problems that result, for the most part, from the high traffic volume and are therefore contrary to the requirements of sustainable development.

To alleviate these negative effects, according to Jaqueline McGlade (2012), more sustainable mobility concepts have to shift in the center of design and development nowadays.

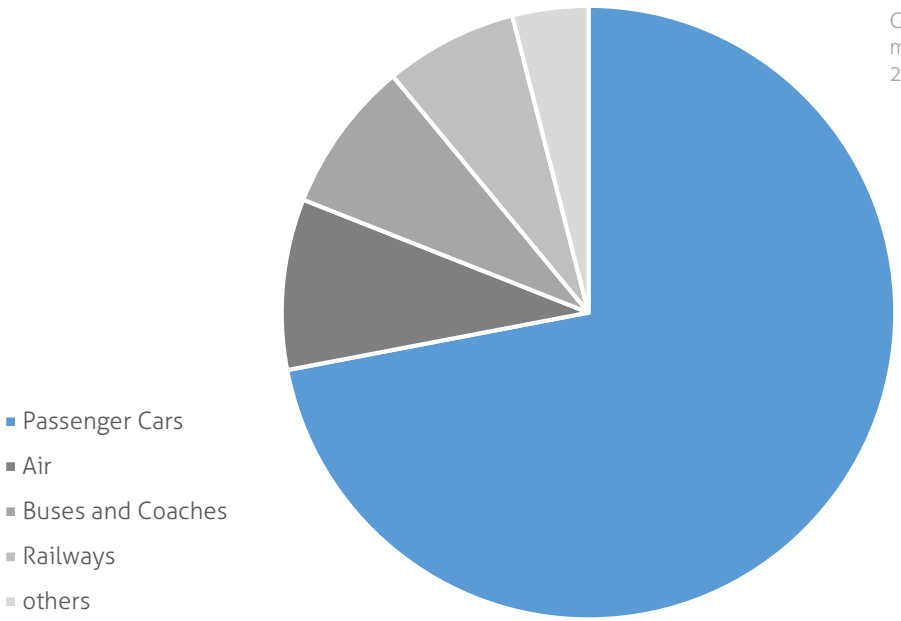
The property-less car use, the so-called car sharing could offer a highly promising approach while preserving the individual mobility. In this context and to contribute to an increasingly sustainable and innovative environment in Greater Lisbon, a sustainable car sharing concept will be designed within the scope of this research project.

2 Problem Identification

2.1 Motivation for a Sustainable Mobility Concept

Throughout the human evolution, transport has always played an important role and is still one of the main drivers of economic growth. Nowadays, individuals and companies are more than ever taking advantage of widespread mobility solutions available on the market, which leads to a continuous increase in the volume and complexity of transport. However, transport is not yet sustainable within the EU and road traffic, consisting of freight and passenger transport, plays a predominant role (European Union, 2015b).

As depicted in Graphic 01, people's increasing need for transport is still mainly satisfied by passenger cars (72%) within the EU, despite improvements in the means of public transport (De La Fuente Layos, Luis Antonio, 2007, n.p.).



Graph. 01: Passenger transport modal split within the EU-28 in 2013 (EEA, 2015, n.p.)

Despite this, other factors triggered the evolution of the over-proportioned number of vehicles in cities and metropolitan areas, which leads inevitably to several environmental effects. For a further understanding the causes and effects will be discussed in the next chapter from the example of Greater Lisbon, Portugal.

2.1.1 Increasing Traffic Volume in Greater Lisbon

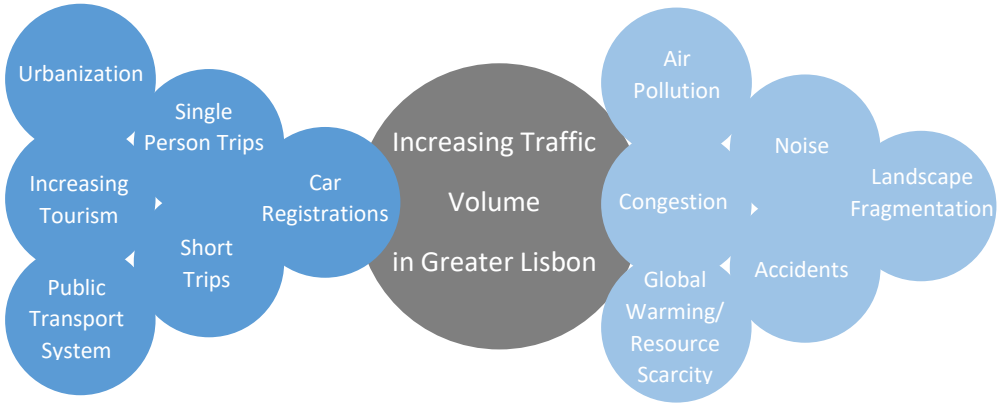


Fig. 01: Causes and effects of increasing traffic volume in Greater Lisbon (own figure)

Lisbon is the capital city of the coastal nation Portugal, situated in the southwestern of this European country and next to Porto, an agglomeration area with a population density of 115 inhabitants per km^2. The population of Greater Lisbon, including the municipalities Lisbon, Amadora, Cascais, Loures, Mafra, Odivelas, Oeiras, Sintra and Vila Franca de Xira, slightly enlarged from 2,042,326 in 2001 to 1,947,261 in 2011 and comprises about 20 % of Portugal's entire population (AMTL, 2012, n.p.).

Furthermore, Lisbon is daily facing an immense volume of road traffic, which rose by 60 % between 1991 and 2001 (Emel, 2005, n.p.). The causes and the resulting effects of this evolution are investigated in the following.

Causes

Urbanization

According to Weber and Hall (2001), urbanization can be expressed as "the fraction of individuals residing in urban areas". The trend towards urbanization, which is globally rising, will lead to a world population that mainly lives in cities up to the year 2050 – 75 % according to forecasts (Figure 02).

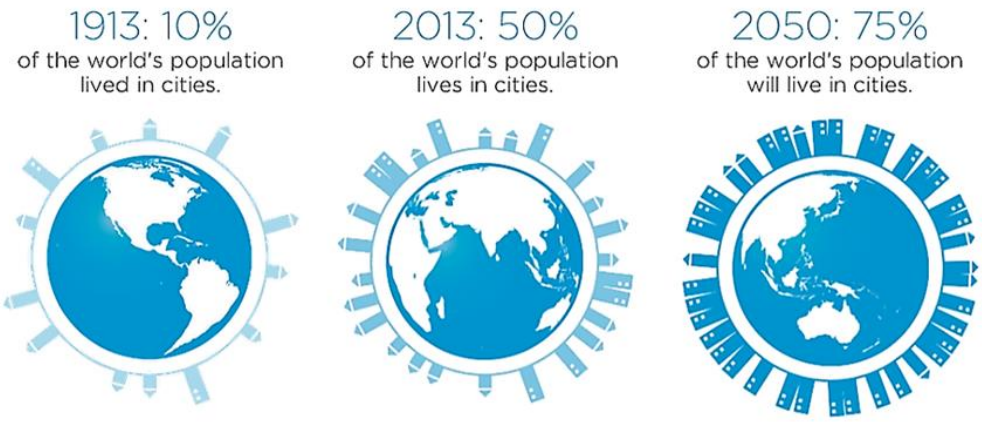


Fig. 02: Percentage of the world's population in cities (Rockefeller, 2013, n.p.)

Europe is already one of the most urbanized continents with 70 % of its total population (560 million) living in urban areas. This leads to environmental advantages on the one hand, since land use and energy consumption tend to be lower in comparison with rural communities. On the other hand, urbanization leads to increased traffic volume in urban agglomerations – environmental problems are the inevitable consequences (J.-L. Weber, 2001, n.p.). The degree of urbanization in Portugal – 60 % – lays slightly under the European average, but significantly above the global trend.

Main reason for the demographic shift towards urban areas is the structural and economic weakness of many rural areas in Portugal and the high concentration of businesses around the two biggest cities – Porto and Lisbon. The growing area of Greater Lisbon represents hereby the highest population agglomeration in Portugal (2,042,326 in 2011), in which Lisbon and Amadora constitute the cities with the highest density of households (AMTL, 2012, n.p.).

Urbanization in conjunction with other factors led to an increase in the road traffic in Lisbon of more than 60 % - from 210,000 vehicles per day in 1991 to 342,000 in 2001 (Emel, 2005, n.p.).

Public Transport System

Lisbon's public transport system is comprised by metro, buses and tram, whereby the majority of the users chooses the bus – 57 % in Greater Lisbon. This results from a limited metro network (only 4 separated lines) and neglected tram investments. One of the most touristic hotspots (Belém) is only connected by one tram and buses which leads to overloads in rush hours (AMTL, 2014, n.p.).

Car Ownership Trends

There has been a strong surge in car registrations in Portugal from 1973 to 2004. Whereas the car registrations in 1973 accounted 710,000, the value rose to 5,996,000 in 2004, which reflects the cultural importance of individual mobility in Portugal (European Commission, 2006, n.p.).

Number of Short Single Person Trips

According to Weckström-Eno (1999) "the Portuguese and Spanish persons are the least mobile ones" in Europe, with predominantly short distance travels. In this context, passenger cars are the most often chosen transport mode, with 10,132 billion passenger-kilometers per year (De La Fuente

Layos, Luis Antonio, 2007, n.p.). As realizable in everyday life, single person trips especially in the rush hour represent the largest share in the total road traffic in Lisbon.

Increasing Tourism

The year 2013 was a record year for tourism in Portugal with more than 14 million people – 4.2 % more than 2012 (Long, 2014, n.p.). Lisbon remains the most popular destination in Portugal with an increasing number of overnight stays (27 %) in the period from 2009 to 2013 (Roland Berger, 2014, n.p.). As a result, road traffic has risen steadily.

Effects

Landscape Fragmentation

One negative effect of road traffic is the landscape fragmentation. The term landscape fragmentation can be defined as a rupture of established ecological connections in spatially separated areas of the landscape. This fragmentation of landscape and water systems is seen as a significant cause of the decline of animal and plant species and lead to a threat to biodiversity (EEA, 2011, n.p.). Increasing traffic is accompanied by road and highway extensions, reinforcing environmental issues.

Noise and Accidents

The major source of noise within European cities is road traffic and is therefore also an essential concern of the people living in Lisbon. A short survey about noise disturbance and health impacts in Lisbon, carried out by Quercus Portugal showed that "people living or studying/working in the municipality of Lisbon are the ones who complained most about road traffic noise", whereby 38 % of interviewee are sanitarily affected by the

noise in an intermediate grade. This includes, among others, stress, anxiety and headaches (Quercus, 2013, n.p.).

Another negative consequence of the increasing transport is the high number of traffic victims, injured or killed each year. Lisbon represents the region with the highest amount of accidents caused by road traffic in Portugal with 21 % in 2010 (INE, 2011, n.p.).

Congestion

Due to the concentration of employment in the center of the city, Lisbon is facing high amounts of commuting traffic through a small number of highways every day. These highways distribute the traffic to a small set of narrow roads which is limited expandable by reason of the hilly landscape. Increasing road traffic therefore leads to inner-city congestions in traffic volume peaks.

Air pollution

The Environmental Protection Agency (EPA) introduced the "National Air Quality"- Standard for particulate matter in 1987. PM10, for instance, describes the category of particles with an aerodynamic diameter less than 10 µm. Lisbon experienced only slight reductions in the PM10 level between 2008 and 2012 (traffic station Avenida da Liberdade). The EU target of 35 days per year for exceeding the PM10 limit values has not been complied in 2008 (82 days) and in 2012 (79 days). 2014 was the first year Lisbon seemed to meet the EU target, but only due to meteorological conditions. NO_2 limits were also breached in 2014 and this trend will continue in 2015 (BUND, 2014, n.p.).

Global Warming and Resource Scarcity

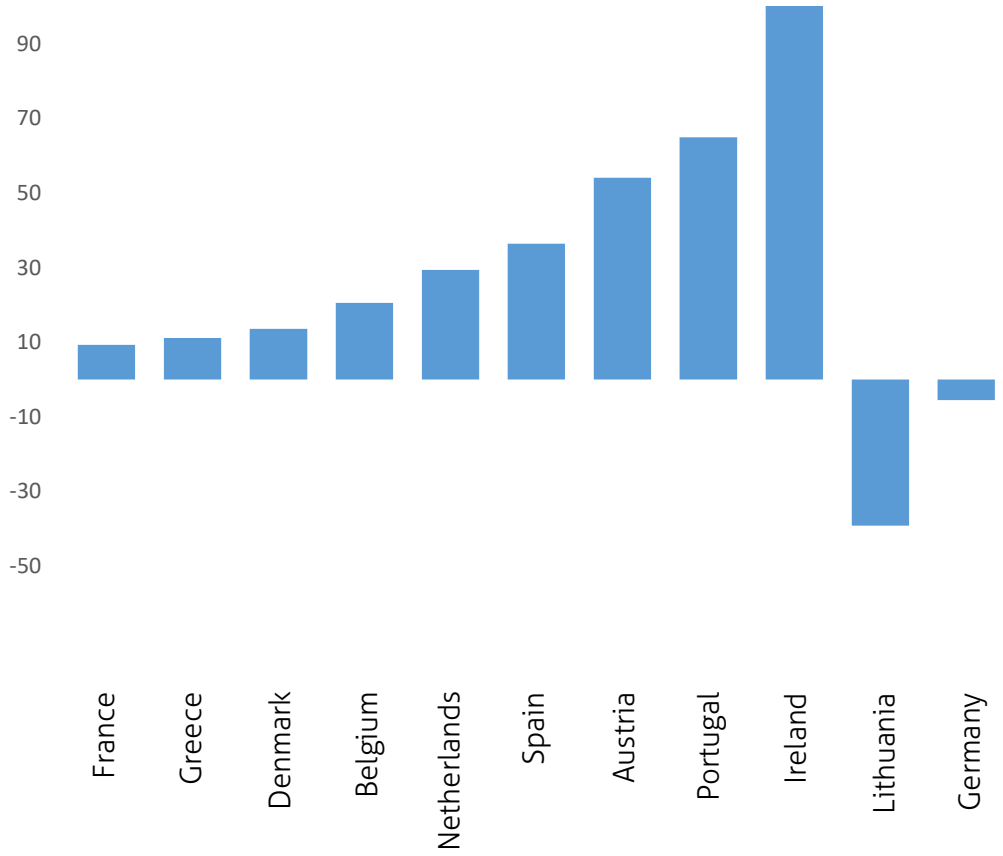
The high demand for fossil fuels, which is accompanied by the increasing traffic is nowadays more than ever closely linked to the problem of rising

emissions. Key words such as resource scarcity, greenhouse effect and global warming are therefore debated controversially at the beginning of the 21st century. The operation of different modes of transport requires energy, in the transport sector mainly obtained by non-renewable resources on petroleum base, which is particularly problematic in view of the natural limitation of the raw material oil and greenhouse gas emissions.

Carbon dioxide, arising with the burning of fuel, is one of the so-called greenhouse gases and takes direct influence on the earth's climate.

Ocean acidification is often referred to be the second carbon dioxide problem, which could lead to an extinction of many animal and plant species. This would directly impact the marine food chain, fishing and hence the human living on earth.

Graph. 02: Change in total GHG emissions from transport (EEA, 2014, n.p.)



As shown in Graphic 02, greenhouse gas emissions caused by transport have risen in Portugal by 65 % between 1990 and 2012. Passenger cars constituted in 2005 the mode of transport with the highest CO_2 – emission share within the EU-27 (EEA, 2011, n.p.).

3 Research Question

Can car sharing be a sustainable solution to counteract the increasing traffic problems in Greater Lisbon?

4 Objectives

4.1 General Objectives

The general objective of the dissertation is underway to design a sustainable car sharing concept for Greater Lisbon that works as much as possible on the principles of an environmentally friendly product development process. This concept aims to reduce the main problems, such as landscape fragmentation, global warming and resource scarcity, caused by the rising traffic volume in the city and will furthermore depict a positive contribute for an increasingly sustainable and innovative environment in Lisbon.

4.2 Specific Objectives

The specific strategic objectives will lead to a reduction of the amount of combustion engine cars in the city and consequentially to an increase of the city's attractiveness and people's quality of life.

5 Research Design

5.1 Research Methodologies

Within the development of this research project a mixed qualitative methodology will find application, comprising qualitative non-interventional and qualitative interventional methodologies.

In this regard, a selection of literature and several surveys by interviews will contribute to the analysis of the existing problems and, subsequently, to a clarification of the research topic. After an extensive gathering of the provided literature in the form of books, articles and internet documents, to gain a deeper personal understanding of the necessary themes, different interviews will be done. In order to satisfy the local requirements – target group and landside infrastructure – interviews will be done with the inhabitants of the city, mainly based on surveys conducted at faculties of the University of Lisbon. Since there are already existing some few contacts to the automobile industry, in particular to a provider of a European car sharing service, interviews will be done to clarify theoretical issues concerning the concept.

Indeed, to facilitate the following work, developing a concept, attuned specifically to the needs of the city Lisbon, a wider field research about present car sharing concepts has to be carried out in form of case study analysis. The selection of the case study will be composed on one hand of any cases that can be found in Europe and on the other hand of cases in countries with the comparable or similar economic and social culture as Portugal.

In the final stage, before defining the conclusion and the recommendations for further research project, the developed concept will be undergone a critical evaluation through active research and a panel of experts.

5.2 Organogram

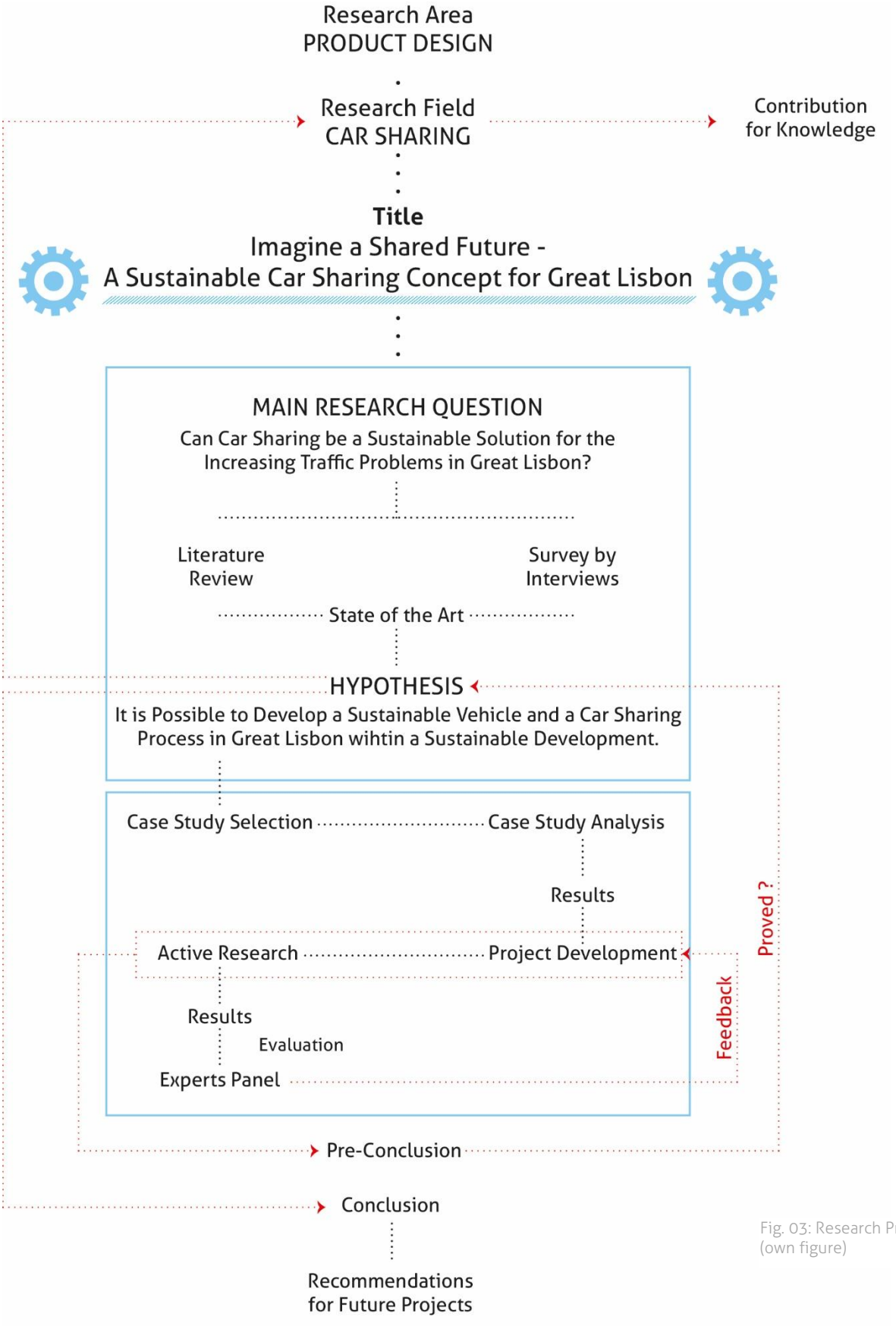
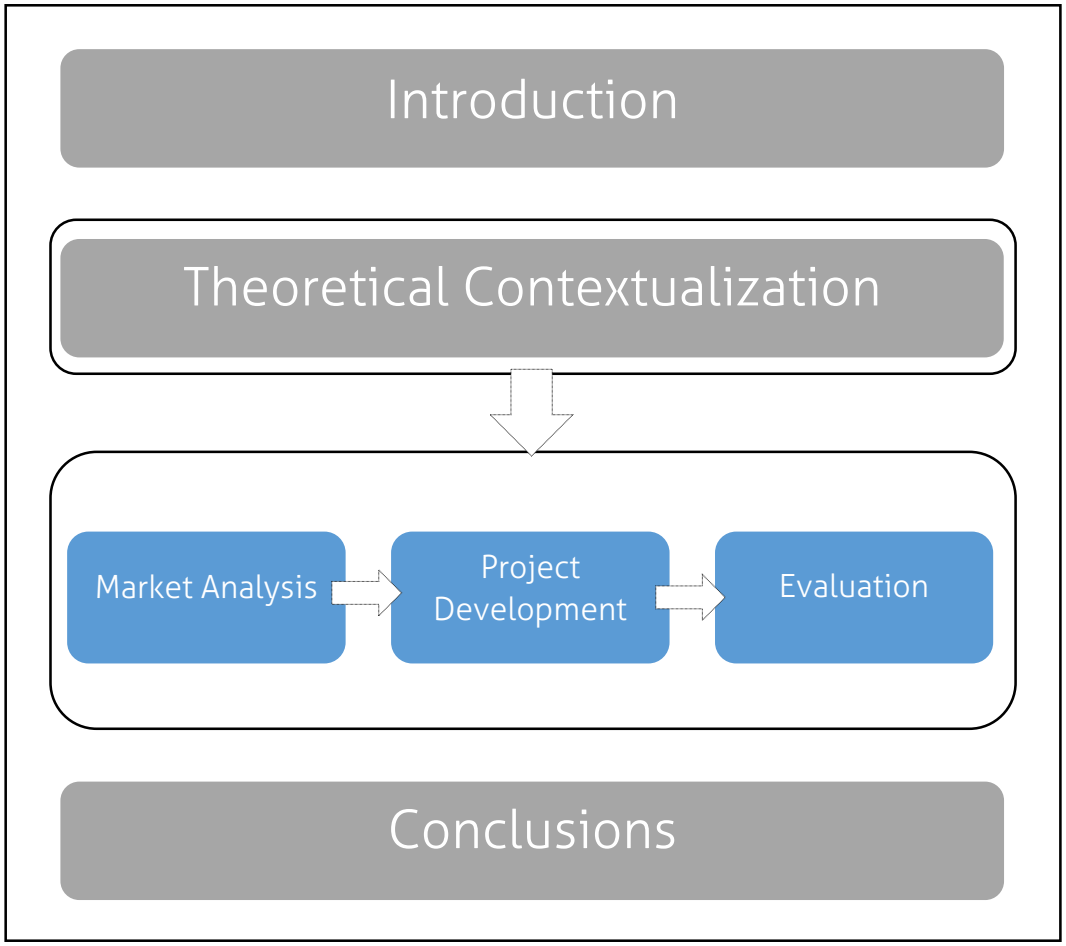


Fig. 03: Research Process (own figure)

6 Structure of the Dissertation

This work is divided into six chapters, which will serve the guidance to the achievement of the overall objective (cf. Figure 04).

Fig. 04: Structure of the dissertation (own figure)



The first part of the dissertation, consisting of the two Chapters "Introduction" and "Theoretical Contextualization", contributes the basis and illustrates the topicality and the relevance of the subject. In the introductory chapter the motivation for the development of the topic, as

well as the problematic are presented. The chapter of the theoretical principles provides a deeper understanding of the terms emerging within the dissertation and constitutes a functionally and content-related introduction of the research issues.

Chapter III, IV and V build up the main part of the dissertation, in which the "Market Analysis", the "Project Development" and the "Evaluation" are standing in the foreground. The market analysis plays an important role in the preparation of a sustainable, reasonable concept development and in the upcoming discussion of the results. Chapter III therefore represents an extensive analysis of already existing car sharing concepts in Europe, and a full customer and location analysis.

In chapter IV the concept, developed within the dissertation, is described. The chapter is composed of the two main parts, the description of the concept and the presentation of the final idea of the product-service system, tailored to the needs and necessities of Greater Lisbon.

Chapter V deals with the final evaluation of the concept and the discussion of the acquired knowledge within the dissertation.

The work ends with a finalising reflection of the implemented objectives as well as a final conclusion and recommendations for further projects.

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Chapter II

Theoretical Contextualization

8 From Sustainability to Car Sharing

"The human creator spirit can make different inventions (...), but he will never succeed to build one that would be nicer, more economical and more straightforward than that of nature, because in her inventions nothing is lacking, and nothing is too much."

- Leonardo da Vinci -

Everybody is talking about it, but hardly anyone knows its origin and the meaning of the word sustainability. Therefore, a thorough investigation is required in advance to understand the possible contribution of sustainable development for a car sharing concept. In subsequent, a thorough investigation of mobility and the connection between sustainability even those will lead over to the definition of car sharing. In the final chapter, the concept of car sharing will be analysed with regard to its sustainability.

8.1 Sustainability

The word sustainability, or sustainable development, has increasingly become a fashionable word in the management floors in recent years, though it is often used contrary to its genuine origin or its actual meaning. However, what exactly is meant by the term sustainability?

Sustainability refers to the "heritage" of the society, which will be left for future generations, including knowledge, tradition, nature and infrastructure. The term originates from the forestry sector and lies in the transition between the 17th and the 18th century, when Saxonian chief mountaineer Hannß Carl von Carlowitz clarified in his work "Sylvicultura Oeconomica", that there are certain principles for sustainable economizing. On the occasion of an impending shortage of wood, due to devastating forest destruction caused by agricultural activities and increasing industrial demand for wood, von Carlowitz purposefully pleads for the sustainable forestry, in which only the amount of wood is taken from the forest as can manage to grow back (Carlowitz et al., 2013, p.98). This resource economic principle, which combines the economic goal of maximum sustainable use of the forest with the ecological conditions of the regrowth, became a role model for a number of subsequent sustainability considerations (Grunwald and Kopfmüller, 2012, p. 14). Hardly the way had paved, the idea of sustainability has found widespread support in the fishing industry in the early 20th century. The objective was analogical: In order to achieve permanent maximum income, the extent of fishing should be based on the reproductive capacity of fish stocks. For a long time, the principle of sustainability thus was largely limited to the forestry and fishing industry, without a significant impact on the other areas of economic activity.

Only in the late 1960s, early 1970s, the resource issue has again become to a significant topical issue, when the relationships between economic growth, social product- and life styles and the exhaustion of resource stocks was discussed more intensively in politics and economy. At the same time the increase of various environmental pollution problems contributed towards a greater attribution on the development debate through environmental issues (Forschungszentrum Karlsruhe, 1999, p. 13). Besides the ecological problems, the problems in the social and economic field

grew, whereupon the UN Commission for Environment and Development (Brundtland Commission), chaired by the Norwegian Prime Minister Gro Harlem Brundtland, began its work in 1983. The Commission, composed predominantly of politicians, had set itself the goal to develop appropriate recommendations for action in order to initiate the process of sustainable development. Through the Brundtland Commission the concept of sustainable development gained access to a wider, even non-scientific public for the first time and developed an understanding of sustainability that is nowadays accepted worldwide as a suitable basis for more concrete strategies (Hauff, 1987, p. 1f). According to the final evaluation report "Our Common Future", published in 1987 by the Brundtland Comission, „sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Grunwald and Kopfmüller, 2012, p. 20). This definition illustrates that a sustainable equitable development has to be provided to improve the living conditions between the present generations, as well as for future generations (intergenerational justice) (Weber, 2008, p. 42f). Thereby, two key concepts can be identified: Firstly, the concept of basic needs, particularly vital needs of the poor in the world, where a primary urgency is granted and, secondly, the idea of limitations imposed by the state of the art and the social organizations to satisfy present and future needs (Stappen, 2008, p. 19f).

One of the most important milestones for the establishment of sustainable development as a global-political model was constituted trough the United Nations Conference for Environment and Development (UNCED), also referred to as 'Earth Summit', in 1992 in Rio de Janeiro (Grunwald and Kopfmüller, 2012, p. 22). At the UNCED, the heads of state of 178 countries were developing strategies to address the environmental and developmental issues and to conclude international agreements (Brand

and Jochum, 2000, p. 25). The Rio Declaration, in which some developmental and environmental policy principles were detained, and the UN Agenda 21, a forty chapter's comprehensive action program for objectives, measures and instruments for the implementation of the concept played the central role in the negotiations. The topics of this political declaration are ranging from socio-economic issues (health, demography, poverty and consumption patterns) over environmental issues (biodiversity, forest, climate, deserts, oceans, etc.) and prospects of specific target groups to the concrete implementation level (technology transfer, science and education, institutions, etc.) (Forschungszentrum Karlsruhe, 1999, p. 17f). The integration of these different topics under the overarching guiding principle "Sustainable Development" has been seen as substantial progress, as it would bring the knowledge of associate that "economic, social and environmental development should be seen as an inner unity" (Brand and Jochum, 2000, p. 30). More publications that describe the sustainable development as a triumvirate of ecological compatibility, social justice and economic efficiency emerged increasingly in recent years. In this context the "three-pillar model" arises, in which the determination of the basic target dimensions of sustainable development takes as far as possible the ecological, economic and social aspects into consideration (Weinreich, 2004, p.21).

8.1.1 Ecological Dimension

The ecological dimension of sustainability emphasizes the with substantive standards elusive value of nature, as well as the detectable finiteness of the natural resources and involves the normative requirement to ensure the permanent stability of the ecological system for future generations (Bauer, 2008, n.p.).

Thereby the functions performed by the system for human activities should be preserved, which includes, inter alia, the protection and conservation of biodiversity and ecosystems, climate change, the maintenance of cultural and natural areas in their original form, and a sparing use of the natural environment in general (Studt, 2009, p. 185).

8.1.2 Social Dimension

The social objective of sustainable development is concerned with the questions of intra- and intergenerational justice and the different lifestyles of people. The focus is here consequently on the equity in terms of access to opportunities and resources within individual countries and societies, as well as in the global distribution conflict between the northern prosperous industrialized countries and the southern, poorer developing and emerging countries. Implicitly, this means to establish a balance of social forces with the goal of achieving a sustainable long term and worth living society. For this purpose, the health and safety of individuals has to be ensured, an equality between men and women has to be implemented, human rights have to be respected and in the context of equitable life chances for all, the access to education and culture has to be guaranteed for everyone (Bauer, 2008; Studt, 2009, p. 186).

8.1.3 Economic Dimension

As part of the economic dimension of sustainable development a qualitative and quantitative increase in the material well-being and an increase in the national product are targeted, whereby the economy has to be set up that it permanently provides a solid basis for earnings and prosperity. The growth shall therefore only extent in a way that subsequent

generations will find the same consumption possibilities to satisfy their need as present generations (Studt, 2009, p. 186). A sustainable economy is therefore concerned about obtaining employment and income, whereby it has to be innovative and competitive and able to pay for the use and consumption of environmental goods itself simultaneously.

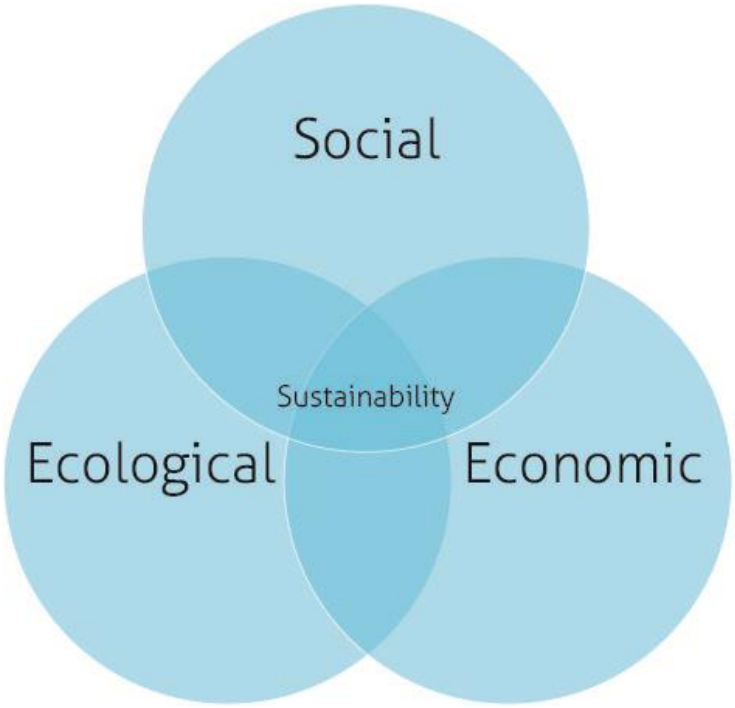


Fig. 05: Dimensions of sustainability (own figure)

8.2 The Sustainable Development Goals of the UN

A new approach regarding sustainable development was recently adopted by the United Nations in August 2015, which expresses the "mission" of sustainable development via 17 sustainable development goals and further sub-divided into 169 targets. According to (UN, 2015, n.p.), these goals and targets seek to "stimulate action over the next 15 years" in the

areas of people, planet, prosperity, peace and partnership, since these issues are "of critical importance for humanity and the planet."
If the goals of the UN are taken into consideration as they are depicted in Appendix 1 a strong interlinkage to the road traffic is clearly recognizable in several goals, which contents are as follows:

- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12: Ensure sustainable consumption and production patterns
- Goal 13: Take urgent action to combat climate change and its impacts
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reserve land degradation and halt biodiversity loss

Obviously, several conflicts are existing in the transport sector nowadays, especially if the example of Portugal and Greater Lisbon is considered, as it was analysed in Chapter 2.1.1. As shown in the problem analysis, the increasing traffic volume in Lisbon is currently trigger of a large number of road accidents and congestions. This fact contrasts to goal 11 as it was formulated by the United Nations.

The efficient use of natural resources, as it is stipulated in goal 12, is far from reality, when considering the high consumption of raw materials, like aluminium or steel, in the production phase of automobiles and the high consumption of petroleum based resources in the utilization phase.
Furthermore, ocean acidification is largely the result of the transport sector, since it is based on the high emissions of greenhouse gases, which goes contrary to the action to global climate change conserve and sustainable

use of the oceans described in goal 13 and 14, especially if the increasing number of car registrations in Portugal is taken into account.
As stated in the problem analysis landscape fragmentation is mainly caused by an increased volume of traffic, which contrasts goal 15, to protect, restore and promote sustainable use of terrestrial ecosystems.

8.3 New Methodological Approaches of Sustainable Development

8.3.1 Bionic

Over time, evolution has developed ingenious solutions for the adaptation to extreme habitats. Whether in the water, on land or in the air – to fulfil the will of survive, special skills and qualities are indispensable. Depending on their habitat, many animals can be extremely energy-saving or able to orient themselves in difficult conditions. Others, for their part, are equipped with an ultra-lightweight, very sturdy body armour. To decipher the secrets of these physical principles and use them as a model for the development of new technical solutions, known as bionic, biologists are closely working together with engineers, architects, physicists, chemists and material scientists.

Leonardo Da Vinci is considered to be the first known pioneer of bionics, who tried to allow people to fly, by observing the functional principle of the birds' wings already in the 16th century. The knowledge he gained from his studies, he wrote down in construction proposals (Kesel, 2005, p. 3). As basic approaches in bionics, two methods can be distinguished. Firstly, the top-down approach, in which a technical problem has already been defined and a solution will be sought in the nature. On the other hand, there is the bottom-up approach, whereby a possibility of implementing is derived

from a biological principle, or a finding in nature (Brickwedde, 2007, p. 175).

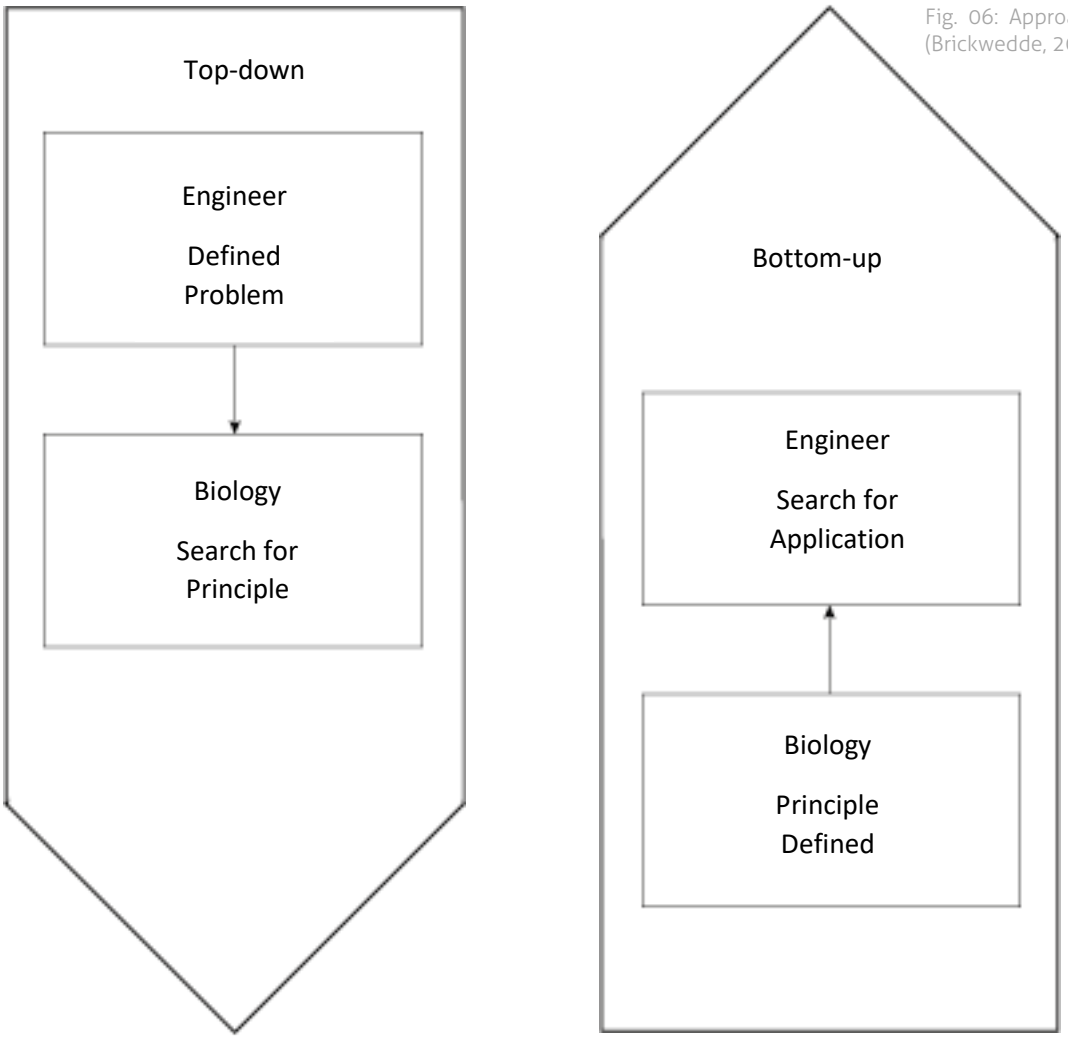


Fig. 06: Approach of bionics (Brickwedde, 2007, p. 119)

One of the best known examples of bionics is the lotus effect, which derived from the biological surface structure of a lotus leaf. Tiny wax crystals – microscopic nubs – on the leaf surface, giving the leaf a rough, nubby structure, are effecting that dirt particles and water droplets cannot

adhere as they only have few points of contact with the sheet. Water drops bead off spherically, taking dirt and dust particles.

Another example, which can be found in the automotive industry, is the transfer of the structure of cat's paws into the tire development to guarantee an optimal power transmission. Cat's paws are optimized for fast acceleration, efficient directional stability and a high stability in cornering, which makes cats, such as cheetahs, a highly efficient hunter, which can adapt to specific needs depending on the situation (Tirendo, 2014, n.p.).

With the help of bionics, new possibilities of sustainable development can be opened up to achieve the goals of sustainability – satisfying the needs of people living today and the simultaneous conservation of resources for future generations (Brickwedde, 2007, p. 123).

8.3.2 Cradle-to-Cradle

As part of a holistic sustainable development the term "life-cycle thinking" has been used for several years, which describes the consideration of the complete product life cycle – production, product use and disposal. Considering the entire life cycle can prevent, that environmental impacts are shifted into other life stages (Ponn and Lindemann, 2011, p. 278). The life cycle is understood to mean the process of resource conversion throughout the entire product lifecycle, starting with the sourcing of raw materials, through the production of the product as well as all transport operations, through the actual use until the end of life of the product. The sequence of the individual phases is based on the chronological-logical order of the product development and the use (Herrmann, 2010, p. 63). The design and product development are the only disciplines that have a significant influence on all life stages of a product - 60 to 80 % of all environmental impacts of a product are set during the development phase

(Ryan, 2008, p. 11). The goal of sustainable development should therefore be, to place the often practiced remedial measures for environmental protection at the end of product life to the beginning of the product life, to thereby completely avoid negative effects on the environment (Ponn and Lindemann, 2011, p. 277).

Especially on the issue of energy, product development can have a high impact on the product life cycle, since energy is required at every stage of the product life. Consequently, measures must be taken to reduce the possible energy consumption in all areas, for example by improving or avoid energy-intensive production techniques. This can be mainly influenced by the choice of materials and the design of the product. Like this, the product developer is able to determine, the consumption of resources, including the production of waste and the emissions. Therefore, low-waste manufacturing processes, recycling capable materials and energy-saving as well as low-emission production methods should be preferred.

In the utilization phase, the product development not only affects the energy consumption. Thus, for example, the designer can avoid the probability of failure of the products and therefore unnecessary energy and raw material consumption as well as emissions by a load-oriented design of the components.

Furthermore, at the disposal phase, the developer has a considerable influence, since he also determined whether the product or its components can be recycled. Especially this important phase has not been given sufficient consideration, yet this stage has a significant impact on the sustainability of products (Schäppi et al., 2005, p. 449f). In this context, the "Cradle-to-Cradle Concept" has been increasingly used recently as an ideal model of a holistic sustainable development.

Unlike the traditional idea of the product life cycle – Cradle-to-Grave – every product within the C2C can be reused biologically or technically after its utilization phase (Braungart and McDonough, 2011, p. 68).

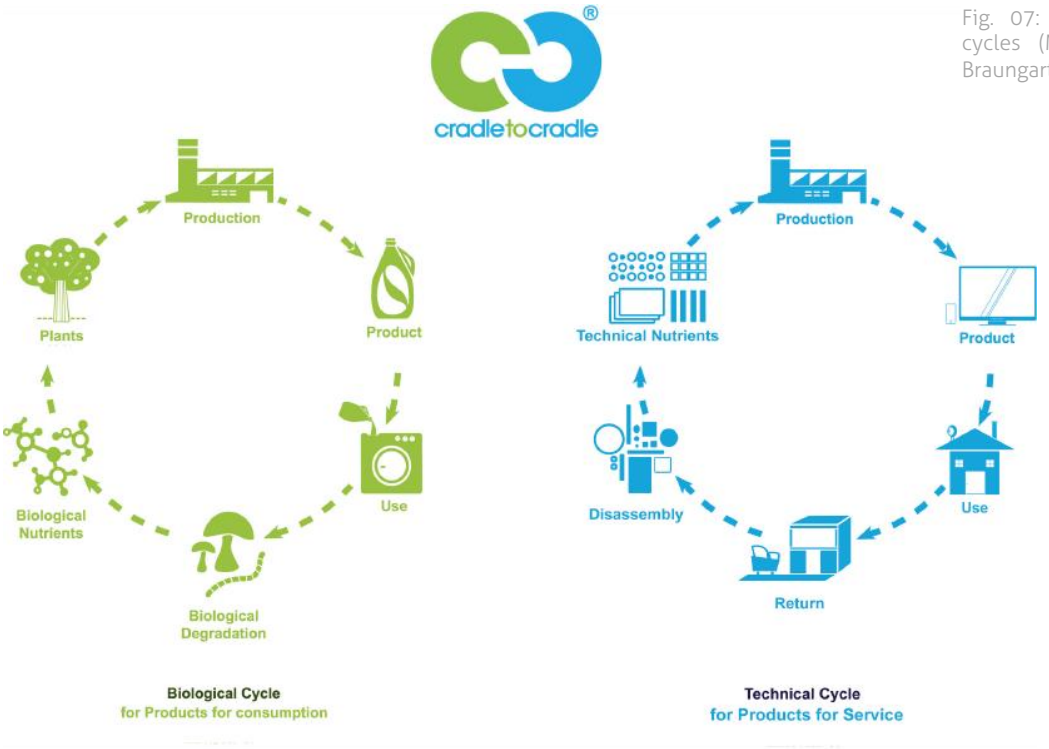


Fig. 07: Cradle-to-Cradle cycles (McDonough and Braungart, 2002, n.p.)

This concept has been developed already in the nineties by the German chemist Michael Braungart and the US-American architect William McDonough and describes two cycles in which the products can either be reused as replacement parts or materials or can be supplied into a natural recycling process in the form of waste, by serving as a raw material for other products (Herrmann, 2010, p. 64). In other words, while the conventional strategies of "eco-efficient" approaches seek to reduce and to minimize the unintended negative consequences of production and consumption processes in its quantitative aspects, the "eco-effective" approach of C2C

represents a quality concept, which is based on the fact that natural and environmentally supportive products and processes are possible to improve the opportunities for the industry. The functioning interactions between natural systems suggest that the establishment of sustainable systems of production and consumption is no question of reducing the size of our "ecological footprint", but rather is the challenge how this "footprint" can be built on natural system as inexhaustible, supportive source (McDonough and Braungart, 2002, n.p.).

However, what steps are necessary for a designer to implement this concept in his product development? Initially, all materials, which are classified as harmful in any way, have to be removed from all production processes. These substances – X-substances – are known to be carcinogenic, mutagenic or can have any destructive influence on humans and animals. The second category is called "the gray list", in which all materials are listed that do not require immediate substitution due to their harmfulness. These also include substances that can be found on the "X-list", which cannot be substituted. In the third category, the "P-list", all substances are listed which do not cause any damage due to usage neither on the environment nor to the people. Finally, in order to enable a holistic implementation of the concept, a complete reinvention of the product must be done. According to this, the entire product concept will be redesigned. For example, vehicles can emit useful emissions to the environment instead of harmful emissions or the carbon dioxide exhausted could be collected and reused in the rubber production (McDonough and Braungart, 2001, n.p.).

In recent years, the concept of C2C found growing favor with a variety of different companies worldwide. In this manner, for example, the Danish shipping company Maersk has redesigned their development process of their container ships regarding the new C2C concept and have designed

the world's largest vessel on this new principle. In detail this means, that all parts that are installed in this ship consist of positive material. Material that emits no pollutants to the sea and which can be further used in other products at the end of the useful life of the vessel (Maersk, 2013, n.p.).

9 Mobility

9.1 The Relation between Mobility, Need and Traffic

The term "mobility" originally derived from the Latin word "mobilitas" and describes the mobility of persons and property in general (Zängler, 2000, p. 19). However, this term can be used in several contexts. For instance, "occupational mobility" is used to express the exchange carried out from one workplace to another (Eckey and Stock, 2000, p. 1). Especially in a modern, work-sharing and internationally interlinked society, mobility can be of fundamental importance. It is not only an expression of the human need for mobility, but also a prerequisite for the economic performance of our society.

As stated above in the problem analysis, individualization in mobility has steadily increased in the passenger transport due to the development of the automobile. The share of passenger cars in the passenger transport modal split within the EU-28 climbed to 72 % in 2012, however, not only due to growing mobility needs – the automobile is today still a status symbol in many cultures.

9.2 Sustainable Mobility

Nowadays it is of particular importance in the transport sector to show the options traffic can have to satisfy both the objectives of sustainable development as well as the prospective needs of a sustainable energy and climate policy. In fact, precisely in the area of passenger and freight transport, the reduction of greenhouse gases represents a major challenge, as on one hand it still satisfies individual mobility needs and freight has to be transported, but so far there is still a very strong attachment to fossil

fuels. Furthermore, according to Ponn and Lindemann (2011) "population growth in recent decades led to an increased consumption of products and services, bringing an increase in the associated waste and the consumption of raw materials". In this context, to create a sustainable mobility, several control lever can be implemented in the stages of product design and product development to reduce the impact of the transport on the environment, which are described in the following.

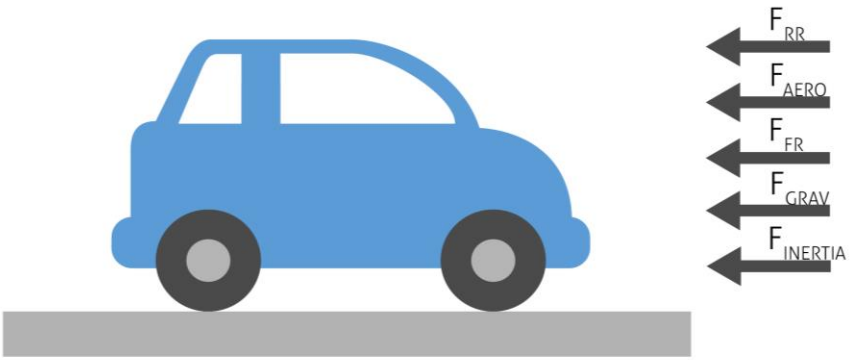
9.2.1 Energy Efficient Vehicles – An Overview

"The fuel consumption of a vehicle is a mirror of the driving resistance of a vehicle" (Mayer, 2006, p.10f). This statement can be also transferred to all kind of drive train concepts, such as electric vehicles or hybrid vehicles and clarifies, that next to the driving profile the influence factors such as air resistance, rolling resistance and friction forces, which are counteracting the movement of the vehicle, cannot be neglected within the energy or fuel efficiency. Using the lower figure (Figure 08), the driving resistances shall be described, with the assumption that this is a vehicle, driving with a constant speed of 90 km/h. To keep up this pace, the accelerator pedal has to be depressed to a certain extent. This process then consumes fuel or electricity and thus energy. If the driver takes off the gas and the car into idling, the vehicle inevitably comes to a stop due to the acting driving resistances - even on a slippery road. Hereby, five major categories of driving resistances can be named (Mayer, 2006, p.10f):

- Rolling resistance forces F_{RR}, which depend on the tire characteristics and the vehicle weight
- Aerodynamic forces F_{AERO}, described by the shape and the dimensions of the vehicle

- Friction forces F_{FR} in moving parts, such as gear box, wheel bearings or break discs due to the vehicle weight and the material properties of the components
- Gravitation forces F_{GRAV} are involved, if the vehicle has to climb a hill and increases with the gradient and the vehicle weight
- Inertia forces $F_{INERTIA}$ are noticeable when accelerating and breaking and are characterized by the gravity and the vehicle mass

Fig. 08: Driving resistance of a vehicle (own figure)



F_{RR}	rolling resistance forces
F_{AERO}	aerodynamic forces
F_{FR}	friction forces
F_{GRAV}	gravitation forces
$F_{INERTIA}$	inertia forces

Considering all these forces it can be said, that overweight is one of the most important control lever for reducing energy losses and consequently for a higher energy efficiency.

9.2.2 Sustainable Materials in Mobility

The sustainability of a vehicle not only depends on the source of energy, whether it comes from an electric battery or a diesel tank. The materials that are used to develop a car also have a major impact on CO_2 footprint, weight and environmental awareness. As described in chapter 5.1.3.2, an accurate planning of the entire product life cycle already in the design phase, can have a decisive impact on the sustainability of a product. This includes in the automotive sector, however, not only the recyclability. By using "green materials" weight and hence air pollutant emissions can be reduced. Thus, automobile manufacturers primarily trust on fiber composite materials, as savings not only in weight but also in CO_2 can be assured. Moreover, by using hemp fibers a holistic sustainable design can be ensured, caused by the fact that this natural product can be returned to the biological cycle.

Furthermore, high research-expenditures are carried out mainly to develop bio-plastics made of natural materials in exchange with the traditional plastics. So, for example, the French engineer Rémy Lucas has developed a plastic using algae breeding in the Atlantic Ocean off the Brittany, which is 100 % plant-based and is ready to be used in the manufacture of plastics (Hermann, 2013, n.p.).

9.2.3 New Drive Train Concepts

In addition to the above mentioned opportunities of the automotive design and development in terms of sustainability, the choice of the right drive train concept plays for the vehicle, plays an important role. Thus, on the basis of new concepts, such as an electric drive in the form of a battery or a fuel cell, not only the effect of noise as described in chapter 2.1.1.2 can

be improved, but also raw materials can be saved that are required when using an internal combustion engine.

9.2.4 Changes in Car Consumption Patterns

Indeed, there are recognizable signs of change in certain European countries, like Germany concerning the car consumption patterns. The focus of younger generations' shifts to just satisfying needs instead of possessing the physical product, not only in terms of mobility. Hence, the meaning of cars as expression of status and prosperity is becoming less and less important (Shimomura and Kimita, 2013, p. 183f). Therefore, in contrary to traditional automobile manufacturers, providers of transport-related product-service systems, like car sharing, shift their business from selling vehicles towards the offering of a product service combination, namely car sharing, to the customer. According to studies on environmental impacts of Product-Service-Systems negative environmental impacts can be reduced by 30 % by the use of car sharing instead of car ownership (Shimomura and Kimita, 2013, p. 183f).

For a deeper understanding of this PSS, named car sharing, a detailed description of the concept will be done in the following chapter.

10 Car Sharing

As shown in the problem analysis, the traditional form of satisfying the mobility needs involves many burdens on people and on the environment, so that the personal transport system as a whole does not conform the requirements for a sustainable development. A key challenge is therefore the establishment of a transport concept that meets the mobility needs in a similar extent as the private car, but at the same time minimizes the negative impacts. Car sharing, which will be examined in this chapter, could represent such a traffic concept.

10.1 Definition and Types of Car Sharing

Car sharing can be understood as an organized form of sharing of one or more passenger cars by multiple users. The car sharing concept is characterized by a decoupling of personal property and individual use, in which the "individual right of use will be replaced by a collective one" (Pesch, 1996, p. 47). The diversity amongst different types of car sharing services is large and in some cases, one operator delivers more than one service model (LeVine et al., 2014, n.p.). Generally three kinds of car sharing variations can be distinguished, as presented below (Collaborative Fund, 2015, n.p.):

- P2P (peer to peer)
  A community owns a fleet of cars and the marketplace matches owners of cars that are available to other drivers to rent

- NFP (not for profit)
  A local organization or community that facilitates car sharing with the goal of changing driving habits over making a profit

- B2C (business to consumer)
  A company owns a fleet of cars and facilitates the sharing amongst members

As the focus of the dissertation lies on the concept of B2C, where consumers hire passenger cars and pay per hour of the service used, a more detailed investigation has to be done. According to BUND (2015) and Le Vine et al. (2014) B2C car sharing concepts can be further subdivided in two concepts, as done in the following:

Station-based car sharing

Station-based car sharing is characterized by fixed rental and return stations. Users typically pick up a vehicle from a parking station and return it to another. The stations usually offer fixed infrastructure like charging points for electric vehicles. Main advantage of fixed stations is the ease of management, since logistics are less challenging in comparison with free-floating car sharing services. However, the provided degree of flexibility for the user is lower (Shimomura and Kimita, 2013, p. 381f).

Free-floating

Free-floating car sharing allows the user to spontaneously access parked vehicles in the operator's geographic zone – reservations are usually not provided. After the vehicle rental, cars can be left in freely accessible locations, which requires a contractual agreement between the car sharing operator and the entity, which manages the parking. Free-floating offers a higher degree of flexibility, but the operating and rental costs are slightly higher than in station-based car sharing (Firnkorn and Müller, 2011, n.p.).

11 Sustainability Analysis of Car Sharing

Changes in consumption patterns are difficult to influence, especially in terms of products with attached social meanings like cars. To move away from individual car ownership to shared use is therefore a challenging task. However, studies on environmental impacts of PSS have proven, that it can be worth it, since by the use of car sharing the negative environmental impacts of traffic can be reduced up to 30 % (Shimomura and Kimita, 2013, p.381f). But not only transportation related problems can be reduced, in fact car sharing schemes offer many advantages and can positively contribute to all three dimensions of sustainable development – social, economic and ecologic. This section therefore aims at describing the specific contributions of car sharing to each sphere.

11.1 Car Sharing in the Ecological Dimension of Sustainability

The ecological dimension of sustainable development considers nature and environmental conditions, in particular preservation of biodiversity, climate protection, the maintenance of cultural and natural areas in their original form and in general a careful handling of the natural environment. The commercial use of nature in the form of raw materials as well as the damage to the environment caused by exploitation and transport burden atmosphere and ecosystem, compromising future habitat and well-being.

Resources and Energy

The production, as well as the operation of passenger cars requires energy and resources. It follows, that the less resources and energy are consumed, the fewer vehicles are produced, and the less they are used. Furthermore, as car sharing reduces the amount of private owned vehicles, it leads to a reduction of vehicles and consequently to a reduction of traffic (Steding,

2004, p. 35). With regard to the energy consumption a distinction must be made, however, between expenditure of energy for the production and use. On the production side, energy, and raw materials are saved due to the fact that the shared requires a lower vehicle inventory and correspondingly fewer vehicles need to be produced (Behrendt, 2000, p. 44).

Emissions

The energy reduction during the production and utilization phase results in lower air pollution and greenhouse gas emissions. A Swiss study, published in 2006, concludes that each active car sharing participant in Switzerland saves around 290 kg of CO_2 emissions annually through his traffic behavior (Haefeli et al., 2006, p. 45). Indeed, if the specific CO_2 emissions of car sharing fleets are confronted with the specific national emissions of European countries, car sharing vehicles tend to emit 15 to 20 % less CO_2, according to Loose (2010). This is particularly relevant, especially in view of climate change and ocean acidification.

All in all, it appears that car sharing already has many positive ecological effects. Car sharing contributes directly and indirectly to resource conservation by the energy and raw material consumption, and by the reduction of the amount of waste. Moreover, car sharing effects on the reduction of greenhouse gas and air pollutant emissions.

11.2 Car Sharing in the Economic Dimension of Sustainability

With regard to the manufacturing costs or costs of service provision, a review of the car sharing compared to the private car is difficult, because this is no reliable data have been published. From the provider's perspective, a car sharing can be most closely compared with a rental car, since in both cases the vehicle rent stands in the foreground.

Thus, the introduction of car sharing brings various economic benefits for both parties – customers and businesses. According to Litmann (2015) and Firnkorn and Müller (2011) the most important cost related advantages of car sharing can be summarized as follows:

- Mobility for small businesses as a more cost efficient and flexible alternative to owning vehicles
- Reduced expenses for households, since vehicle ownership is a considerable cost factor
- Increased economic productivity by allowing job seekers the access to cars if needed for job searching and employment
- High fixed costs, especially of cars with alternative drive systems, are spread among many users (economies of scale)

11.3 Car Sharing in the Social Dimension of Sustainability

Health

The social and societal effects of property-less car use are closely related to the environmental effects of traffic. Car sharing contributes to a reduction of pollutant emissions, which leads to ultimate health benefits for both the users and non-users of car sharing. The reduced performance and the displacement effect on other modes of transport at the same time, decreases the risk of health problems as a result of noise pollution emanating primarily from motorized traffic as depicted in chapter 2.1.1.

Quality of Life

According to UBA (1998) the street space in particular, plays an important role for the quality of life in cities, the dominance of the private car contributes to a deterioration of the living conditions caused by the high traffic volume.

Children hardly can stay unaccompanied or play in the street by their selves and older people feeling insecure and limited in their foot mobility - the urban road space lost its residence and communication function. As a result, both the attractiveness of the living environment and the quality of living decrease. A high level of quality of life can also be achieved only by avoiding the harm caused by transport, in particular air and noise pollution, as far as possible. Through the shift to public transport, bicycle or car sharing, the property-less car use in principle has a positive impact on the quality of life.

Nevertheless, since car sharing simultaneously contributes to all three dimensions without emphasizing any in particular, it can be concluded that car sharing in fact is able to deliver positive outcomes.

12 Synthesis

Against the backdrop of a growing size of the world's population and the associated environmental problems especially in metropolitan areas all around the globe, the previously chapter aimed at a theoretical contextualization of the terms sustainability, mobility and car sharing, which will support the understanding of the different topics within the consecutive course of this dissertation.

For this purpose, the different definitions of each term have been presented firstly, from sustainability in general, over the importance of sustainable development and the different approaches in sustainable mobility through to the presentation of car sharing as a modern concept of sustainable mobility in metropolitan areas. To conclude, the car sharing system was evaluated with regards to its sustainability in the ecological, social and economic dimension.

The investigation revealed that indeed, car sharing can be a sustainable solution for the traffic related problems in cities such as Lisbon. The lower quantity of individual vehicles leads to a reduction of the waste of resources as well as the energy consumption and emission of greenhouse gases. Furthermore, as vehicles are mainly used twice a day for commuting, car sharing can cause improvements in cost efficiency for individuals, likewise companies. On the social dimension of sustainability, it could be shown with the help of this analysis, that car sharing can lead to a more habitable environment with regards to health and the overall quality of life.

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Chapter III

Market Study

14 Market Research

"We're only at the beginning of the process where everything we consume, whether it be goods, services, entertainment or finances, will create a digital trail. Once you've got a digital trail, you've got data. Once you've got data, you have the basis for insight."

- Martin Hayward, founder of HAYWARD Strategy and Futures -

In order to receive insights into existing concepts of car sharing and the needs of potential customers of a new and local service, an extensive market research constitutes an indispensable prerequisite within this project. The market analysis provides information that are relevant for forecasting future customers, competition and environment developments. Within a thorough market research target groups and their needs are analysed and competitors and environment developments are assessed, in order to elicit differentiation and competitive advantages and to successfully position a new car sharing concept in the market. The market research will help to further answer the following questions:

- Which markets and customer segments shall be served?
- Which specific products and services shall be offered?
- Which trends will affect the products and services?

The following chapter aims to answer these questions in order to develop a concept, suitable for the local conditions of the city of Lisbon.

15 Competition Analysis

The following section aims at the implementation of a selective analysis of three car sharing providers, of which two rank among the market leaders in Europe. The purpose of this study is to identify the respective strengths and weaknesses of their product-service system in order to gain useful and actionable insights for the further development of the concept within this dissertation.

15.1 Methodology

The methodology used in the competition analysis is based on one hand on the micro-environmental SWOT-Analysis, to point out "the strengths, and weaknesses, representing internal factors of the company and the opportunities and threats, representing external factors" (van Boeijen et al., 2013, p. 73). On the other hand, a radar chart serves as an overall competitive comparison, using the following criteria. To gain greater insights into the processes and to obtain further technical and economic information, a registration was carried out with two car sharing providers. Furthermore, two interviews were conducted with the same companies.

- Overall Costs

  These particularly include the costs for the registration, for using the service, extra fees and diverse rewards for recharging and / or refuelling. Therefore, the company websites, offers and customer experiences have been consulted.

- City Suitability

  Depending on the particular cities in which the services are implemented, the concepts are evaluated with regards to the local adaption, mainly of the vehicles. As the car sharing service is primarily applicable within metropolitan areas, the size of the vehicles has a major impact on this criterion. Thereby, the vehicles are rated and compared using their specific length and wheel base to ensure ideal parking ability as well as small turning circles, suitable for narrow streets.

- Flexibility

  The flexibility of a car sharing service is premised on the overall concept of the company. Whether it is a free-floating or a station-based service. The accessibility within the renting zone of the vehicle is a key criterion, which influences on the willingness of the customer to use a service. As all three companies offer the possibility to make a reservation for a predetermined period, this issue also contributes to the flexibility.

- Sustainability

  One decisive factor to evaluate the sustainability of the several car sharing services is the average emission of the ecologically harmful greenhouse gases of each fleet. For this purpose, all the vehicles of the fleet of each provider are listed and technical specifications are analysed to finally calculate the mean value (see Annex 1). Another defining criterion for sustainability is the resource efficiency; a vehicle with combustion engine uses the scarce becoming resource oil, electric vehicles on the other hand are powered by electricity,

which will be composed more and more of renewable energies within the EU in the following years (European Union, 2015a, n.p.)

- Availability

  Every car sharing provider offers the service of searching cars around the user's position, using a map indicating the location of all vehicles available. This information and the number of vehicles within the provider's fleet build up the basis for the evaluation of the availability criterion.

- Handling

  To perfectly value a car sharing concept, it is the best way to test them. Therefore, the evaluation of the criterion of the handling is mainly based on experiences, while using two of the services (CityDrive and car2go). Main factors influencing the handling are the procedure of registration and the usability of the service while renting a vehicle, e.g. the accessibility of the car, if it can be used with a smart phone or member card and the valuation of the whole procedure during receiving, using and delivery of the vehicle. As the third concept could not have been experienced, the data to evaluate the handling are based on website information and internet research.

15.1.1 Car2go

Fig. 09: car2go smart (smart, 2016, n.p.)

Having started as a pilot project in October 2008, Daimler was the first company to offer its own car sharing scheme, called car2go. In the first phase of implementation, only employees of the Daimler-research centre in the German city Ulm were allowed to test the service consisting of 50 special equipped smarts. Due to its solid reputation and success in the initial test period, the company decided to extend the scheme by offering to the public 200 smarts in the following year (Stefan Gramlich, 2011, n.p.) However, whilst the original purpose in Ulm was it to test the general acceptance of the concept and stabilize the technical systems, a second pilot project was generated, which should apply the concept to the international market in Austin, Texas. The capital of Texas is significantly greater than Ulm and is distinguished by its open-mindedness and an extraordinarily engaged citizenry, which made it the perfect area to test the readiness of the consumers to participate in a car sharing community. In the end of the year 2012 then, car2go started with establishing smarts with

pure electric drive to their mobility concept, by offering 300 vehicles to the citizens of the German city Stuttgart (Mercedes-Fans, 2012, n.p.)

Down to the present day, car2go was able to increase its number of users worldwide to 1.2 million, 700,000 of these only in Europe. The business area they own nowadays consists of 29 locations, 15 in Europe and 14 in North America, and they operate in 8 countries worldwide with over 14,750 smart fortwo vehicles – 1,650 of them pure electric drive smarts (car2go Group GmbH, 2016b)

Car2go black, a new concept within the car2go car sharing service, was implemented in February 2014 and offers in contrary to the traditional blue car2go a station-based car sharing with black B-classes. The background here is simple: people using car2go should be able to rent a larger vehicle to travel longer distances between cities and to carry more people or luggage in the car.

According to an interview, conducted with the Chief Product Officer of car2go William Knapp, who is in charge of leading the operations throughout North America, the two cities with the highest usage rate nowadays are Berlin in Germany and Vancouver in Canada.

Service strategy

Before using the cars, every user is required to undergo a registration procedure, in which firstly the personal data have to be send and a registration fee with the amount of 19,00 € has to be paid immediately. Occasionally, car2go offers reductions for registration or usage to attract new customers. When the personal information is verified, every user is requested to visit a validation station, bringing his identity card, driving license and a previously send QR-Code to provide the final examination

and registration. Subsequently and only after the validation at the station, the customer can use the service of car2go.

Car2go offers, as many other providers, a mobile phone application for an easy usage of the whole concept, which enables to search for cars nearby, make reservations, access the vehicle, start and end the rent and manage the finances. Until July 2015 they additionally offered the purchase of a special member card to access the vehicle, but since this change of their concept new customers are only able to use the service when downloading the app. Inside the vehicle, the customer can find finally the key of the car for further usage.

The car sharing concept used by car2go is based on a free-floating system, there are no fixed stations of pick-up and return of the vehicles. They simply offer the possibility to return or charge the electric vehicles at the exclusive car2go charging stations (car2go Group GmbH, 2016a, n.p.).

Tariff structure

Table 01: car2go tariff structure (car2go Group GmbH, 2016a, n.p.)

Unit	Price in Euro*
Per minute driving (incl. 50 km)	0.29
Per minute parking	0.19
Per km over 50 km	0.29
Per hour maximal	14.90
Per day maximal	59.00

* including fuelling / charging, assurance (deductible of 500 €), cleaning and maintenance

In addition to the base tariff, there are also extra fees, as for example for lost keys, airport pick-up and end rent outside the service zone with costs up to 350.00 €. Furthermore, all the vehicles have fuel cards, which can be used by the customer to refuel or recharge the vehicle at defined stations. Doing so, the user receives 10 minutes free driving on his account. Payment is done by credit card or direct debit procedure. Furthermore, various minute-packages are offered from time to time, ensuring minimal prices. Before starting the ride, a reservation of 30 minutes of the vehicle can be done freely.

Strengths

In terms of strengths, car2go offers an eco-friendly service that focuses on sustainability and mobility, by offering a fleet consisting of only one type of vehicle, the smart fortwo. In many cities around the globe they implemented a pure electric fleet, as in Madrid and Amsterdam, which turns them in terms of sustainability to the "greenest" car sharing provider on the market. Many car sharing users may mention, that a fleet without a broad variety is not adequate, but in terms of city usability it is a main concern of car sharing providers to offer vehicles that are perfectly suitable for small and narrow streets. As William Knapp mentioned, a low fleet variety also leads to consistency as the customers know how the car works and it is therefore easier to handle. With regard to the cost efficiency, car2go offers a solid plan, using rewards for recharging or refuelling of the vehicle by the consumer and a user-friendly reservation period of 30 minutes. Further strengths can be seen in the internationality of the concept. The car2go system is only located in key big cities that allows a high success rate

Weaknesses

Particularly with regard to the handling, car2go shows weaknesses, such as the converting of the complete system from the use of member cards to the solely use of a smartphone app to access and open the vehicle. Furthermore, the low fleet variation also shows weaknesses in terms of target groups, as the target market is smaller than it would be with a greater fleet variation. According to a study, conducted by the German Öko-Institute in Berlin, many users of car2go mentioned, that the process of renting would be too complicated and that the vehicles are not easy to locate (Öko-Institut e.V., 2014, n.p.).

Opportunities

As car2go is the market leader worldwide, they can achieve economies of scale on the car sharing market and consequently they are able to reduce their fixed costs. Furthermore, they are already expanding their business by entering new markets in new countries. This will give them the chance to also diversify their portfolio and their service and to achieve the social perception of the service car sharing as a public transport system. A great opportunity for car2go can also be seen in the fact, that their "big brother" Daimler AG is standing behind the service, what enables them to continuously improve their products to meet the changing customer's needs by new technologies and innovations. New technologies, as the electric vehicle also built up competitive barriers against any rivals using cars with combustion engines.

Threats

One of the main threats for car2go is certainly the risk of new competitors entering the market, offering more sustainable and cheaper services at local level. Many habitants may favour the car sharing provider made in their own country. Furthermore, car2go is endangered by the offerings of a high fleet range by competitive providers.

As car2go offers its service in various countries with different government structures, changes in rules or regulations in the particular state can negatively affect the company and its concept. Politics can increase car2go's risk factors, as governments can quickly change even business rules.

15.1.2 DriveNow

Fig. 10: DriveNow i3 (DriveNow GmbH & Co. KG, 2016, n.p.)

Other market entries of carmakers such as BMW reflect that Daimler is not the only "big player", seeking to find success in the car sharing segment. DriveNow, a car sharing joint venture of BMW, MINI and Sixt, represents the biggest direct competition for car2go. Herby, Sixt takes care of the logistics and distribution within this concept and BMW and MINI are providing the vehicles. The project started in June 2011, with a fleet of 300 vehicles in Munich. BMW clarified already in the initial stage of the service, that DriveNow consequently will be based on "first-class products and services", offering only high-quality premium vehicles, such as diverse BMW 1 and MINI models (Frank Wiesenstroh, 2011, n.p.). Since the introduction of the new electric vehicle concept BMWi, the car fleet was extended by 810 of this innovative product until the present day.

At this current point in time the car sharing-joint venture of BMW Group and Sixt SE owns a fleet of 3,970 cars in total worldwide, ranging from the electric driven BMW i3 over several MINI models to a comfortable BMW X1 or BMW 2 Cabrio. Their business area is composed of nine cities in five

different countries – including, apart from Germany, Austria, Great Britain, Denmark and Sweden. Under the name "ReachNow", as BMW recently announced, they are introducing a pilot project similar to the European concept for the American market. It will be implemented in Seattle and will consist of 370 vehicles, 20 % of them pure electric. The American concept will show some major differences to its European counterpart, such as the possibility for BMW customers to let their private MINI or BMW i3 to other car sharing users. Like this, costs as for example for maintenance can be reduced, when sharing the vehicle. Furthermore, they will offer special delivery and chauffeur services within this concept, enabling the customer to be picked up at home (Almut Stollberg, 2016, n.p.)

Service strategy

The registration with DriveNow is as simple as car2go, personal data have to be send in advance and a registration fee of 29.00 € needs to be paid. After the verification of the necessary information, it is requested to show up at one of the validation stations to present the identity card and driving license.

After the registration and validation process, the cars can be searched and booked using an application on the smartphone, tablet and computer or by telephone. Accessing the vehicle can then be done with help of the app or with the member card, every new customer receives for free when registering for the service. Inside the vehicle, no keys are needed, the engine starts by using the customers' PIN and the start-/stop- button.

The concept of DriveNow car sharing is a free-floating system, the cars can be picked-up and parked at any place within the service area (DriveNow GmbH & Co. KG, 2016, n.p.).

Tariff structure

Table 02: DriveNow tariff structure (DriveNow GmbH & Co. KG, 2016, n.p.)

Unit	Price in Euro*
Per minute driving (incl. 200 km)	0.31 – 0.34 (depending on vehicle type)
Per minute parking	0.15
Per km over 200 km	0.29

* including fuelling / charging, assurance (deductible of 700 €), cleaning and maintenance

As is the case with car2go, DriveNow offers additionally to the base tariff, different packages to minimize the minute-price. They are either bookable for months or only for trips inside the vehicle. Extra fees are charged in the cases such as lost keys, airport pick-up and administrative offences with costs up to 250.00 €. Again, all the vehicles can be refuelled or recharged by the customer, receiving 20 minutes free driving bonuses. Payment is also done by credit card or direct debit procedure. The free reservation period of DriveNow is 15 minutes.

Unfortunately, the service of DriveNow could not be used and tested within the scope of this dissertation and the information for the SWOT analysis therefore are based on the findings on the company website and customer forums.

Strengths

In terms of strengths, DriveNow offers a high fleet variation, what leads to a higher customer satisfaction. The introduction of the new BMW i3 in nearly all of the cities is a good step in terms of sustainability as it reduces the overall emission of carbon dioxide in metropolitan areas.

Just like car2go, the BMW car sharing service uses a reward system for the customers for recharging and refuelling of the vehicles offering 20 minutes free travelling.

Weaknesses

The DriveNow concept shows one major weakness in terms of cost efficiency. The prices in general are higher than the average of other car sharing providers and are composed of various ranges depending on the vehicle and the season. Furthermore, the cost overview is very confusing in terms of the packages they offer. On the one hand, it is able to choose of four different packages in one group that are only bookable inside the car and are only available for one trip. On the other hand, packages are applicable in a "prepaid"-way for monthly use.

As the joint-venture car sharing service offers as many different types of vehicles, it gives more the impression of a traditional car renting than a real car sharing system.

Opportunities

If BMW is expanding their business area, they can benefit of the high awareness level of the two brands BMW and Sixt. Consequently, and due to the fact, that they are offering a wider range of different vehicles, including electric vehicles, they can achieve a growing social acceptance of the concept of car sharing in general.

Threats

As with many other car sharing provider one of the main threats can be seen in the possibility of new market entries of local competitors. Many customers may tend to prefer a car sharing provider that is not owned by a big company, such as BMW or Sixt. Another threat, as in the case of the car2go concept, politic changes in the different countries can influence the company in a negative way.

15.1.3 Citydrive

Fig. 11: Citydrive Adam (Citydrive, 2016, n.p.)

As it can be found in the most European capital cities, Lisbon offers its own car sharing service at a local level. Starting in 2014, Citydrive is a car sharing service offered by a young start-up called Mobiag, founded by João Félix. To introduce car sharing to the local markets, Mobiag initiated Citydrive as a pilot project starting in Lisbon with 40 vehicles. The concept of Mobiag, if successfully implemented, follows the approach of a central management of all car sharing services in Portugal.

The fleet of 40 vehicles consists of 20 Opel Adam and 10 cars each of Skoda Fabia and VW up (ionline, 2014, n.p.).

Service strategy

The registration process for using the service of Citydrive involves an online sign-up on the webpage of the provider, including the upload of the respective copy of the ID card and driving license. Furthermore, personal information and the fiscal number have to be indicated to be able to step forward. The new user does not have to pay any registration fee or has to

visit a validation station. As soon as the registration is accepted, a deposit of a minimum of 20 € needs to be done online to use the vehicles. Unlike, the other car sharing providers the payment is done through a kind of "prepaid" – system.

To make a reservation of a car and to book a trip, there are two ways offered. On one hand, a map on the website of Citydrive enables the customer to search for the vehicles nearby and to book it afterwards, On the other hand, the vehicle can also be searched through an application; in both cases the vehicle then can be accessed and returned using the app.

The Citydrive concept is, as the majority of all car sharing services, based on a free-floating system, there are no fixed stations of pick-up and return of the vehicles. The vehicles can be used within a predefined service zone which is divided into three areas. If the trip is ended within the green zone, mainly limited by Alfama and Santos along the river and Campo Grande in the north, the vehicle can be returned without any extra charge. Furthermore, a small green area exists in Parque das Nações. If parking in the yellow zone in turn, including also the areas of Belém, Benfica and Portela, an extra fee of 10 € after 12 hours of none use of the vehicle is calculated. The overall service area of the Portuguese territory can also be travelled on, ending the trip however is not allowed (Citydrive, 2016, n.p.).

Tariff structure

Table 03: Citydrive tariff structure (Citydrive, 2016, n.p.)

Unit	Price in Euro*
Per minute driving (incl. 20 km)	0.29
Per minute parking	0.10
Per km over 20 km	0.29
Per hour maximal	9.90
Per day maximal	69.90

* including fuelling, cleaning and maintenance

Unlike the previously described car sharing concepts, CityDrive does not have a clear structured cost overview, such as assurance deductibles. The range for extra fees is between 10 € for parking outside the service zone or transport of animals and 500 € for damage repair or replacement of parts. However, they also offer a free reservation period of 15 minutes before entering the car.

Strengths

During the registration and the first use of the service, a type of relationship was built up with the employees of Citydrive. Whenever any uncertainties arise, it is able to directly contact them via Facebook or phone. A major strength therefore, can be seen in the high customer loyalty. In addition, the easy registration process, including the zero registration fee and the great overall impression of the cars can be mentioned. Citydrive owns a new fleet of three different types of small vehicles, all of them can be used by four persons or for the purpose of shopping, without losing out of mind the ability of easy parking.

Weaknesses

As the service is in its pilot phase, the concept still shows some weaknesses, in particular with regards to the procedure of booking and accessing the vehicle through the application and online. The smartphone application can only be downloaded when possessing an Apple phone, the service hence cannot be used by people using another phone provider. Furthermore, the vehicles can only be accessed and returned by smartphone and have thus a bounded customer group. During the test drive, conducted within this dissertation the application was not able to book the vehicle, neither on the website nor on the smartphone. Only after some changes in the programming it was able to use the service.

Another weakness can be seen in the fact, that the service cannot be used by any foreigner, as the registration can only be done when possessing a local fiscal number. However, since there is a big group of Erasmus students in Lisbon, growing from year to year, it could be a recommendation to enable habitants from other countries to use Citydrive.

Opportunities

At this current time, Portugal is still not on the radar of the big car sharing companies such as car2go and DriveNow. As a result, Citydrive can use the opportunity to increase their service by enlarging the market and their amount of vehicles and growing to a local market leader. The unsustainable public transport system in Lisbon can also be seen as an opportunity for DriveNow. As the citizens are dependent on any means of transport, due to the hilly landscape, an extensive marketing programme could lead to a higher level of awareness and consequently to a higher usage rate.

Threats

As described in the chapter "Problem Analysis", the southern European countries not only use their car as a way of transportation but rather it reflects a status symbol. Social acceptance could therefore present a major threat for DriveNow in the near future. The idea of car sharing is still not well known and the usage rate still keeps within a certain limit. Indeed, another menace can be seen in the potential market entry of competitors, such as car2go and Citydrive. Car2go is expanding its market continuously.

15.1.4 Competitive comparison

In view of the criteria discussed in chapter 11.1, the results for the present market study with regard to the competition analysis are as follows:

- Overall costs:
  Due to their clear structured cost overview, including coupons for registration and free minutes for recharging and refuelling, car2go offers the most efficient service among all the three. Citydrive does not charge any registration fees, but for a range of 20 kilometres per ride the usage rate is too high. On the other hand, the low operating range is more than adequate for a car sharing service that is mainly used within a city or metropolitan area. DriveNow's cost structure is too complicated and also too expensive.

- City Suitability:
  Among all the three car sharing provider car2go has the best city suitability, based on the size of the vehicle, mainly calculated on the basis of the vehicle length and wheel base. All three vehicles of Citydrive are considered to be small size cars, but for a city such as Lisbon, with the narrow streets and small parking spaces, they can be too big.

- Flexibility:
  As Citydrive is a relatively young car sharing provider, the vehicle fleet is composed of a small selection of cars available. This criterion makes it nearly impossible to be flexible when perceiving the service. On the basis of the fleet, DriveNow on the other hand, can be seen as a car sharing provider with a very high flexibility

- Sustainability:

  As stated previously, the sustainability of the car sharing fleet is a very important factor, particularly with regard to this dissertation. With an average of 87 g CO_2/km car2go owns the "greenest" vehicles, followed by DriveNow with 96 g CO_2/km and Citydrive represents the bottom of all three with 180 g CO_2/km.

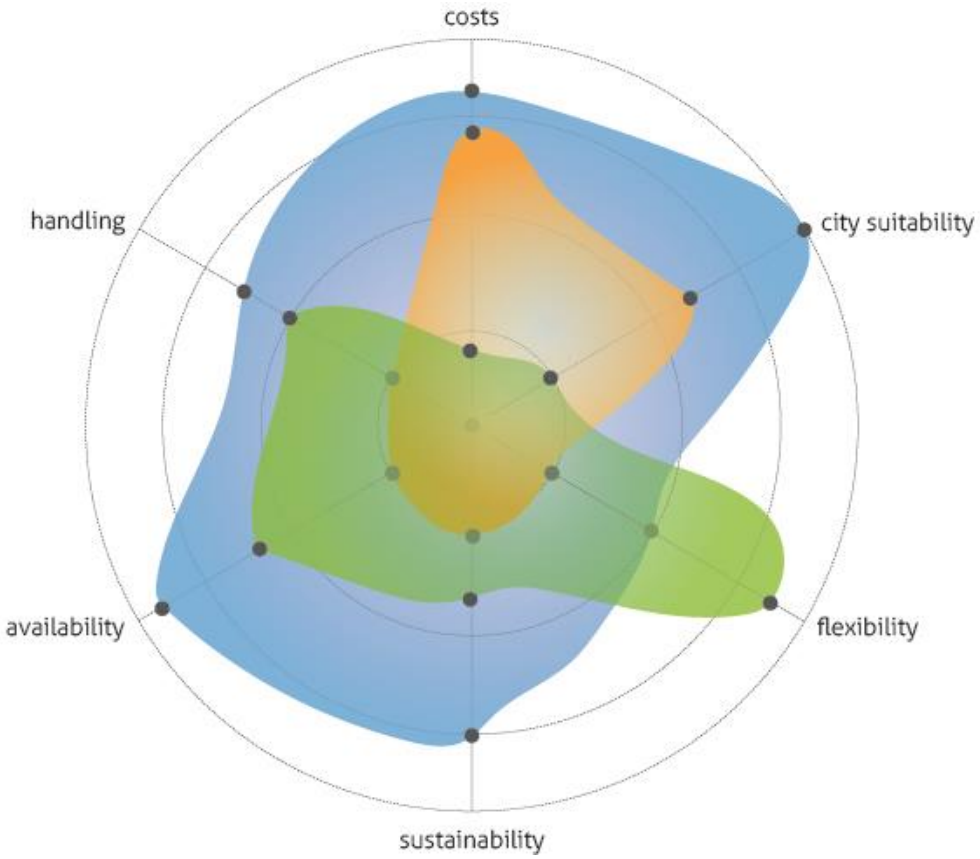
- Availability:

  As car2go offers its service in many metropolitan areas, with a relatively high amount of vehicles per km^2 business area, they can be considered as the provider with the best availability. The service area of Citydrive is still very small with a limited amount of vehicles and has therefore a very small availability.

- Handling:

  Of course, Citydrive has the opportunity to grow on the local market as they are still in a pilot phase of their service. However, at the current point of time, the handling of the service is very unsustainable. The vehicles are only accessible for people possessing a smart phone and moreover only for Apple users. All three car sharing provider offer an own application for smartphones, tablet and computer and the handling therefore is very user-friendly, also during the use of the vehicle.

Fig. 12: Radar chart comparison (own figure)

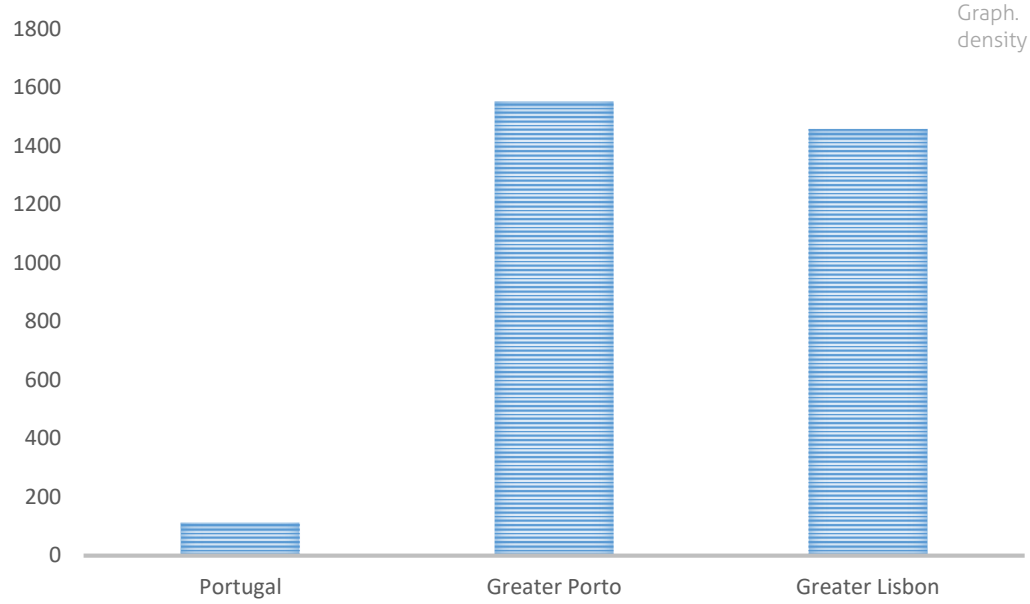


16 Location Analysis

After carrying out an extensive competitive analysis and a description of the car sharing provider that is already operating in the Lisbon area, a following analysis will give necessary insights about the local circumstances. In order to allow a detailed characterization and evaluation of the local conditions, the analysis will focus on the age structure, population density and purchasing power. Furthermore, prior to the necessary establishment of a car sharing service, that may use electric vehicles, the topic of an intelligent charging infrastructure is of great importance and will also be analyst hereafter.

16.1 Population Density

As the car sharing concept developed within this dissertation will find application in Greater Lisbon, it is of great importance to firstly investigate the population density in this area. The demographic density is measured in habitants per square km in Portugal compared to the two major cities, Porto and Lisbon. According to Graphic 03, the countries density accounts 113 habitants / km^2, slightly under Europe with 116 citizens (Eurostat, 2015, n.p.). According to the National Institute of Statistics, the city with the highest density represents Porto with 1,552 residents per km^2, closely followed by the capital city Lisbon, counting 1,458 residents per km^2. Summarising, it can be said that the population density in Lisbon is adequate to establish an efficient car sharing service.



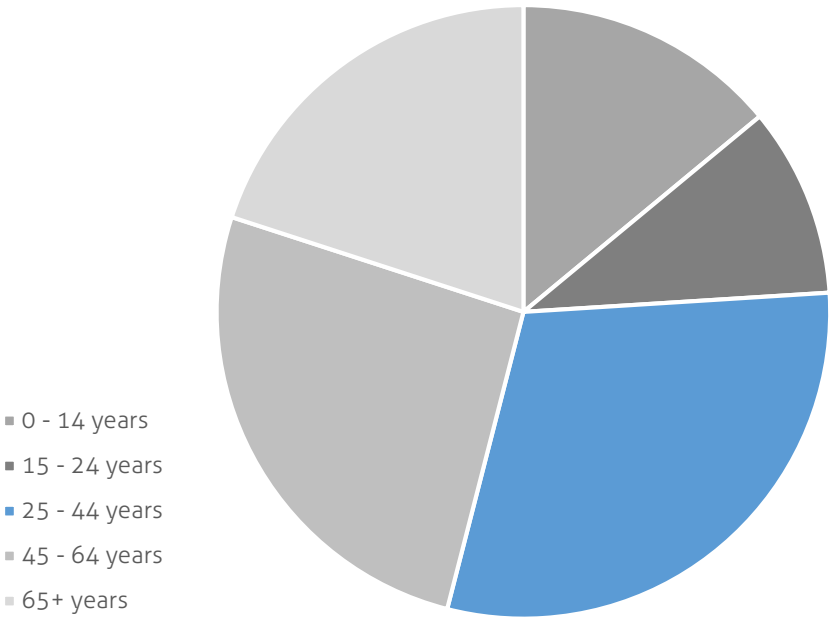
Graph. 03: Population density (INE, 2013, n.p.)

16.2 Age Structure

Another criterion to evaluate if the concept of car sharing will be a success in a new business area, is the distribution of age groups in the respective location. Thereby, within recent years, the user group of the classical car sharing shifted from the "green-alternatives" and "transport-political actives" in the early years to young families and students nowadays. The age group on the other hand did not change remarkably, in the 90s as well as today the largest part of users falls into the age group of 25-45 years.

As seen in Graphic 04, the major share in the age structure of Great Lisbon is composed of 25-45 years with 30 % and represents therefore the main target group for the car sharing concept.

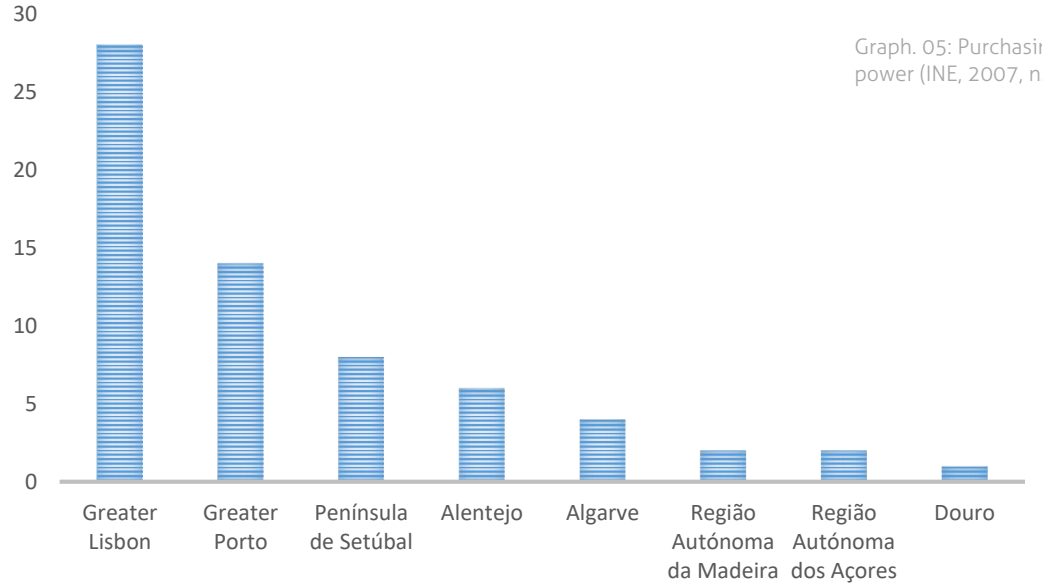
Graph. 04: Age structure (INE, 2002, n.p.)



16.3 Purchasing Power

To adapt a car sharing concept, tailored to the Portuguese market, it is of great relevance to analyse the purchasing power. The purchasing power is a recognised reference to determine the consumption potential on the target market and provides necessary knowledge about the capital region with the highest spending power. The purchasing power is determined based on the calculation of the nominal net household income of the population excluding payment obligations such as apartment rent and insurances (GfK GeoMarketing GmbH, 2016, n.p.)

As can be seen from Graphic 05, Greater Lisbon represented in the year 2011 the region with the highest percentage of purchasing power in total of the country. With 28 % it is approximately twice that of Porto with 14 %. As a result, from an economic perspective, Lisbon can be seen as the most attractive region in Portugal to establish a customized car sharing service.



Graph. 05: Purchasing power (INE, 2007, n.p.)

16.4 Charging Infrastructure

Since the aim of this project is to develop a car sharing concept, which can contribute to a more sustainable environment in Lisbon, including the improvement of noise and air pollution, it appears reasonable to design an electric vehicle. Closely related to this, it is therefore of great importance to analyse the local conditions concerning an adequate widespread charging infrastructure in the, for the concept striven, neighbourhood. The focus hereby lies mainly on the charging network, distributed by the Portuguese company Mobi.E. On a national level, the network comprises 441 charging points in total, on which electric vehicles can be parked as well as charged. Furthermore, the analysis of the dissemination of the charging stations is showing a high concentration in the Lisbon area (see Figure 13).

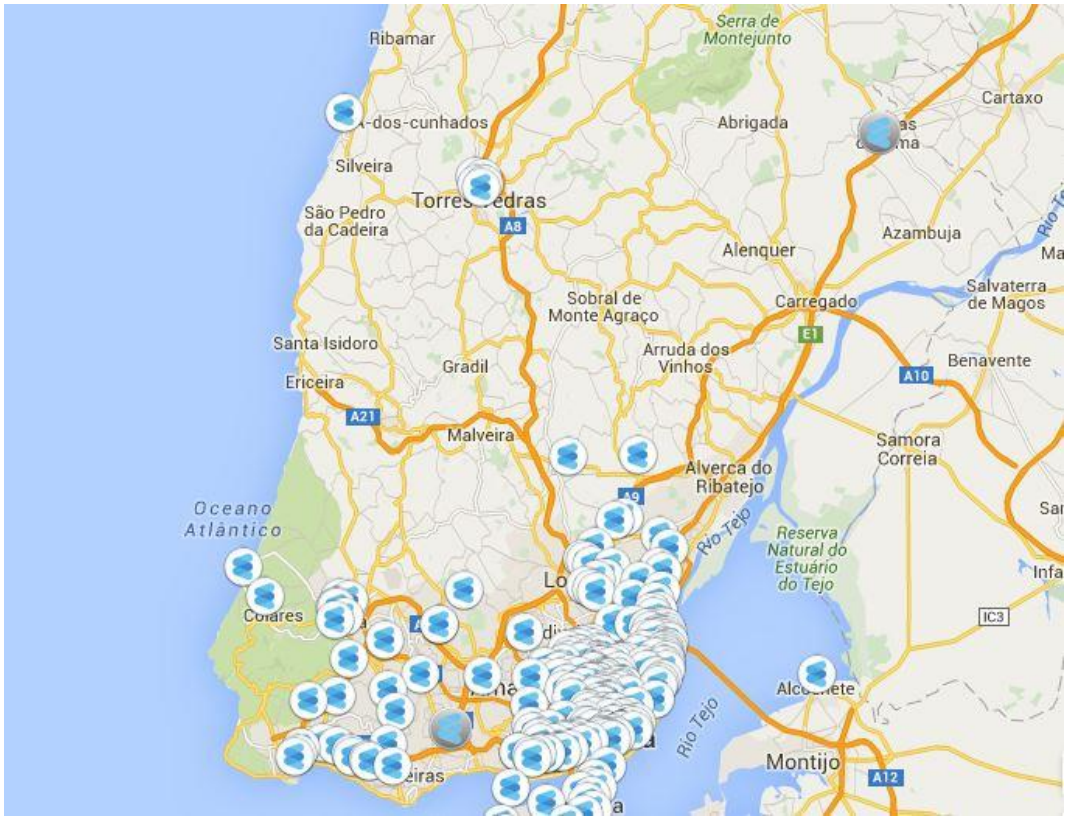


Fig. 13: Charging infrastructure Mobi.E (Mobi.E, 2016, n.p.)

17 Customer Analysis

In order to develop a successful product-service system it is indispensable to experience information about potential customers, their situation, requirements, needs and wishes.

17.1 Methodology

The methodology used to carry out the customer analysis within this dissertation was based on an online survey, conducted with the help of SurveyMonkey, a web-based software tool for personalized questionnaires. The survey questions are provided in Annex 1. As described in the location analysis 30 % of the population in Lisbon belongs to the age group of 25 – 45 years and according to Mobilario, 80 % of the users of car sharing in other countries, such as Germany, possess at least a higher education level or they are employed in an educational work relationship. Accordingly, it can be assumed that the main target group of a car sharing service in Lisbon can be found mainly at the Universities as professors, researchers, faculty staff and students.

In order to obtain a sufficient set of evaluable results, the survey was distributed among various faculties belonging to the University of Lisbon and among friends and further individuals outside the university, using facebook. With the use of mailing lists, provided by some departments, the survey was spread among four faculties, the Instituto Superior Técnico, Faculdade de Medicina Veterinária, Instituto Superior de Ciências Sociais e Políticas and Faculdade de Ciências.

The questionnaire, composed of 26 questions, is further divided into the following three main categories:

- Personal data:
  The questions concerning personal characterisation give information about age, gender, profession, place of residence and can help to define a more personalized concept.

- Mobility behaviour:
  The mobility behaviour, including information about car ownership and use of public transport systems, should help determine whether the habitants of Lisbon are aware of the traffic related problems and their daily use of diverse transport systems.

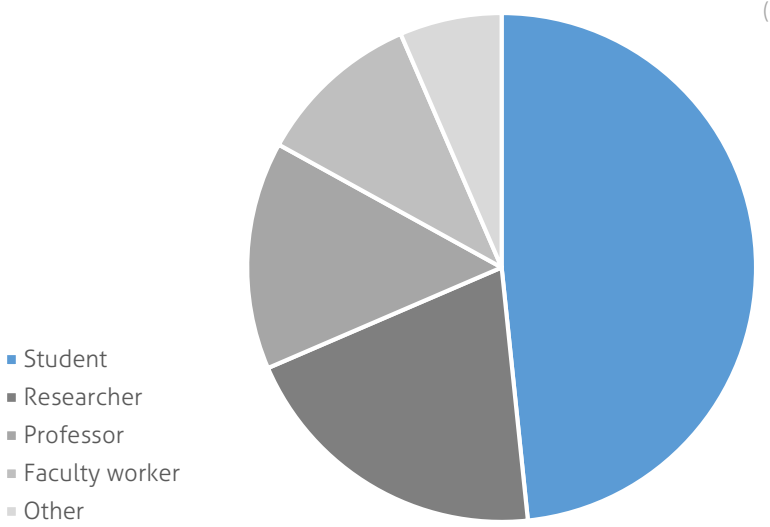
- Car sharing:
  Within the framework of this category the participants were asked about their awareness and their level of knowledge in relation to car sharing in general. Afterwards, with the help of the example of car2go the principles of this product-service system was explained. In order to be able to further evaluate if car sharing could be a sustainable solution for Lisbon the motivation to become a member as well as reasons have been surveyed. Before ending up with three open-end questions about personal thoughts concerning car sharing the participants could answer about usage and conditions linked to the concept, which provides further information about the willingness and acceptance of the collaborative economy in Portugal.

17.2 Evaluation of the Results

17.2.1 Personal Data

On the whole, 125 persons have participated the online survey, of which 48.4 % were students, followed by the second largest group, faculty researchers (20.2 %).

Graph. 06: Profession (own figure)



33.1 % of the respondents belong to the age group 25 to 34 years, followed by 18 to 24 years (31.5 %) and the age group of 35 to 45 years with 22.6 %. The age groups with the highest amount of participants is thus equal to the results of the location analysis, stating that the age structure represented the most in Lisbon is in the group between 25 to 44 years. Slightly more women than men responded to the survey, by a margin of 59 % to 41 %. However, most of them indicated their distinction of nationality as Portuguese, living directly within the area of Lisbon (44 %) or in one of the surrounding regions Oeiras (11.2 %) and Sintra (10.4 %).

According to this information, the service area in which the car sharing service will operate has to be adjusted.

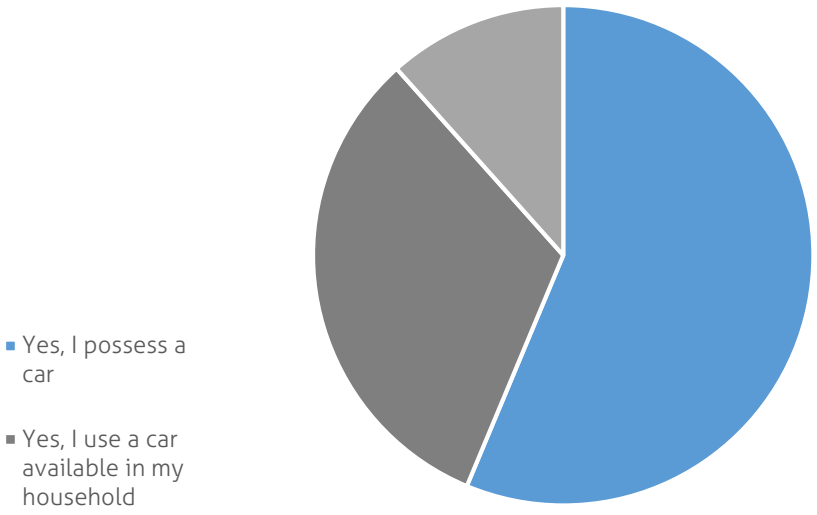
Thus, the interviewees responding to the web-based survey had the following personal characteristics:

- The median age was 30 years
- The respondents where slightly more often female than male
- Nearly the half of all interviewees were students, followed by researchers
- The Faculdade de Ciências was the university with the highest response rate
- The respondents were mostly Portuguese, living directly in Lisbon, Oeiras or Sintra

17.2.2 Mobility Behaviour

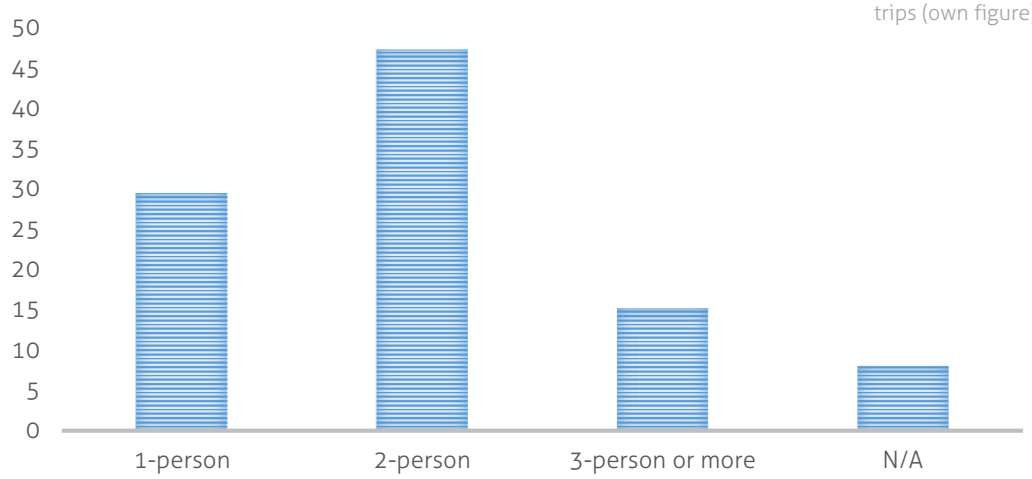
As shown in Graphic 07, 56.3 % of the respondents, answering the question concerning car ownership, mentioned that they have a car at their disposal, 32.1 % can use a car available in their household. In addition, the cars are mostly used daily (38.1 %) or at least regularly (23.9 %), to get to the university or workplace.

Graph. 07: Car ownership (own figure)



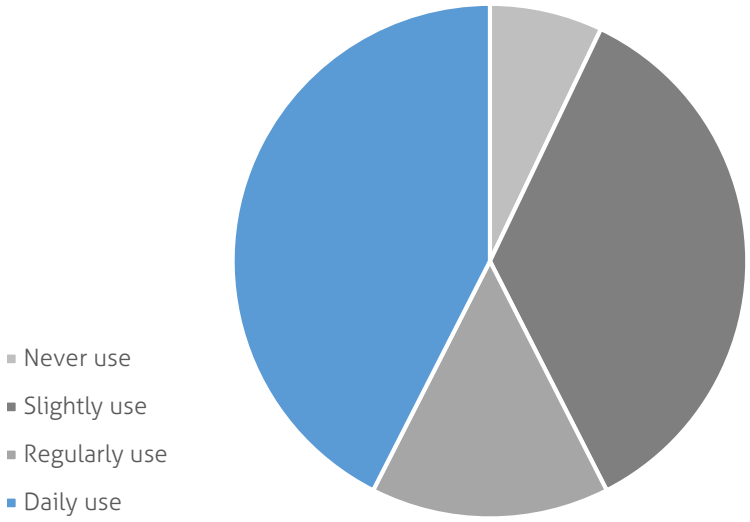
Nearly the half of the interviewees have stated that the major share of trips they are using the car for is made by 2 persons or even only 1 person (29.5 %). As a result, it can be established as fact that the cars seen on Lisbon's streets are either too large or the use of the vehicles is not as sustainable. Furthermore, on an average day, the cars of the respondents are never longer in use than 50 minutes.

Graph. 08: Major share of trips (own figure)



Contrary to the findings about car ownership, described in chapter 2 (Problem Identification) over 90 % associate with cars, that they are only one very convenient type of transportation, it is not only status symbol.

Another unexpected result of this survey was obtained with view of public transport systems. 42.5 % uses the public bus and train system of Lisbon daily, only 7.1 % never uses them.



Graph. 09: Use of public transport system (own figure)

Respondents participating this survey had the following mobility behaviour:

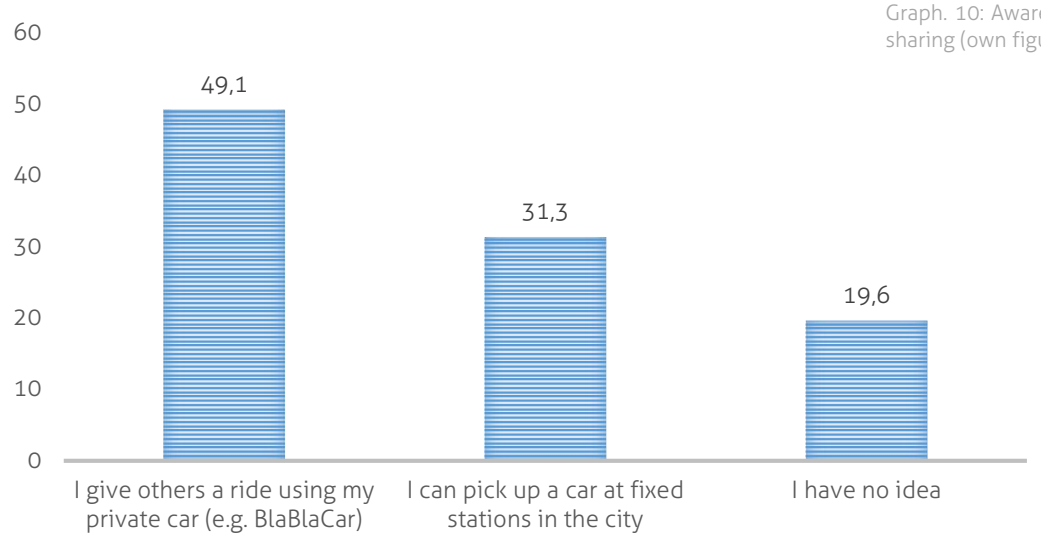
- Nearly all the respondents have a car at their disposal, over the half possess an own car
- The car in their possession is used daily or at least regularly
- The car is mainly used to get to work or university, to make holiday trips or visiting the family living elsewhere in the city

- The major share of trips done by car are 2-person trips, never longer than 50 minutes per day
- For nearly all the respondents, cars are only one very convenient type of transport and nearly the half is using public transport systems daily

17.2.3 Car Sharing

Before the interviewees were able to continue, they were asked to give their thoughts of car sharing, using one of the three following given answers. The purpose of this question is it to learn more about the local awareness of car sharing.

Graph. 10: Awareness of car sharing (own figure)



As expected, over the half of the participants of the study are not aware of the concept of car sharing. 49.1 % think of car sharing as a ride sharing, giving others a ride with their own vehicle and only 31.3 % of all persons that answered this question already knows about car sharing. After a quick

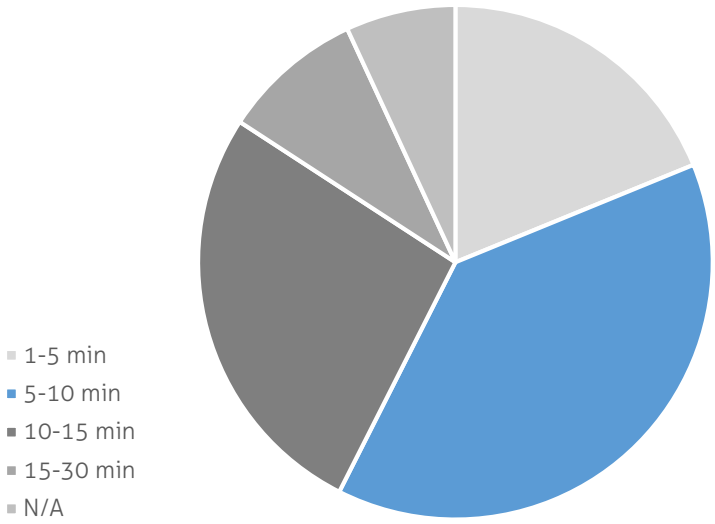
description to inform the interviewees about the concept of car sharing, they were asked if they could imagine to use the service. Only 7.9 % answered this question with no, the others are either sure they would like to use (59.4 %) or they are not sure about the use (32.7 %). The responses suggest, that a high proportion of the respondents are still not aware of the real meaning of the concept and are thus not sure to use it.

Just as within the category of mobility behaviour, the participants were asked about the type of trips they would typically use a car sharing service. The results are similar to these of car ownership, most trips would be done to get to the university / workplace. Hence, it may be deduced that a car sharing service could perfectly serve for short trips within the city area, twice a day.

In order to be able to coordinate and match the local needs to the concept, the interviewees were asked about their financial ability and the price they expect to pay, as well as if they possess a smartphone with permanent internet access. According to that, more than 50 % would not anticipate spending more than 25 € per month on car sharing. 59.4 % are in the possession of a smartphone with permanent internet access, only 9.9 % do not possess a smartphone.

As car sharing would serve as a short-term means of transport that is only used whenever needed, it is important to figure out the willingness to walk to the next location to pick up a car. Using this result, the number of vehicles spread over the city can be calculated for the service.

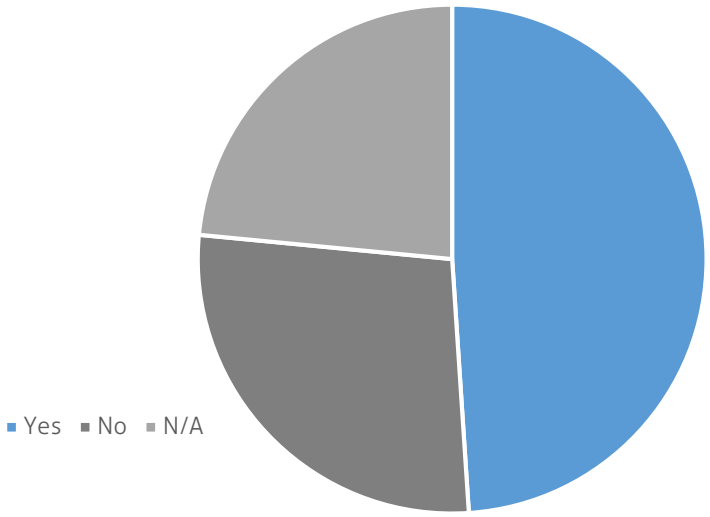
Graph. 11: Walking distance (own figure)



As seen in Graphic 11, 38.6 % would not walk more than 10 minutes, 26.7 % not more than 15 minutes. In this criterion local conditions as for example hills may also be considered.

As car sharing is seen as a sustainable solution to reduce traffic related problems within metropolitan areas, the persons surveyed were asked about the reasons, why car sharing would appeal to them and if a car sharing membership would encourage them to increase the usage of more sustainable transport modes, such as public transport systems. According to the results, the interviewees are very well aware of the problems, such as air pollution (60 %), inner-city traffic jams (41 %) and the high amount of vehicles (38 %). 49 % could also imagine, that car sharing would encourage them to increase the use of other transport systems.

Graphic 12: Higher use of public transport system (own figure)



The internet survey conducted for this project offered respondents the opportunity to identify disadvantages they connect to the concept of car sharing with the help of an open-ended question. According to the respondents, the main disadvantages are:

- The car may not be available whenever it is needed (e.g. in a case of emergency) or it could not be close enough: **34.5 %**
- The high price for using the service: **24.1 %**
- The distance to the next vehicle may be too long: **17.2 %**
- The cars may lack in cleanliness due to the use by many people: **8.6 %**
- They are not aware of the consequences in a case of accident: **3.4 %**

Multiple responses were permitted, so these percentages add up to more than 100 %.

In order to be able to develop a tailored concept for the needs of the Lisbon habitant, the survey furthermore offered to the respondents the possibility to describe, what the perfect car sharing service or vehicle should offer. 52 of the interviewees answered to this question with these ideas:

- Low and fair prices for the service: **38.5 %**
- Strategic distribution of the vehicles, many locations to pick up and return the cars: **19.2 %**
- Immediate availability of the car: **17.3 %**
- Linked accessibility to the public transport system: **9.6 %**
- Small cars, easy to handle and easy to park: **9.6 %**

Some very specific ideas also included:

- "The service should not be paid with smartphone, but with a smart card, to be accessible to all, without discrimination."
- "Internet connection"
- "While you are travelling on the car, could tell people inside, the zones where you are passing, main events or nice sports nearby, or give indications on the window, like augmented reality."
- "The service should have different types available: small cars for daily trips and family cars for weekend / vacations."
- "GPS, electric powered, clean interior, mobile payment."

In the last open-ended question provided within this survey, the interviewees were given the chance to explore their creativity by giving

their ideas about the future mobility. The respondent rate was very low, 42 persons answered this question. Some of the ideas were as followed:

- "We should invest a lot in electric vehicles and bikes. And of course get our public transportation better and cheaper."
- "Improving public transport systems and encouraging car sharing (instead of 4 people going from and to the same places in separate private cars, using only one)."
- "Self-driving electric cars that you could catch like a taxi and be driven wherever you needed for a monthly fee."
- "Autonomous vehicles upon reservation, that will pick you up and drop you wherever you want (like a taxi without a driver). Tele transportation (kidding)!"
- "Vehicle (cars, bikes) sharing in cities and possibility to travel to other cities with rented cars - people who live in cities would be able to use public transportation and still have a car to drive long distances if necessary"
- "A city with large areas without road traffic of private cars, only buses, ambulances, cargo lorries, trams, taxis, 100%electric cars and cars from car sharing schemes"

18 Synthesis

In the course of this chapter an extensive market analysis was conducted, in order to identify the main competitors acting on the European market as well as on the local market, the local conditions have been investigated to evaluate whether car sharing could be a successful solution and a customer analysis was able to give information about the car sharing awareness and acceptance.

The competition analysis of three different car sharing providers, the two global players car2go and DriveNow and the local company Citydrive, was carried out with the help of a SWOT-analysis and a radar chart. Latter of those included six predefined criteria with which all concepts were contrasted. As regards to the competitive research it has been significantly shown, that car2go can be seen as the major competitor on the car sharing market, as they targeted the highest score on five of six criteria in the radar chart. Especially in terms of the city suitability they possess the most sustainable solution, due to their unilateral fleet of smart fortwo.

The local conditions have been investigated within a location analysis in terms of population density, age structure, purchasing power and the charging infrastructure, necessary for the implementation of a concept using only electric vehicles. The investigation revealed that Lisbon shows a very high population density, the second highest after Porto and that the largest age group constitutes of habitants between 25 and 45 years, which leads to the conclusion that the largest amount of people living in Lisbon is in possession of a valid driver's license. The purchasing power, based on the calculation of the nominal net household income, amounts 28 % - twice as the amount of Porto. Moreover, the fundamental feasibility of car

sharing in Lisbon has been proven by pointing out the availability of an extensive charging network, already existing in Lisbon.

In a final assessment, a customer analysis lead to the most important information for a further development of the concept. Based on the analysis of the population density a questionnaire, consisting of 26 questions in three different categories, has been sent to different faculties of the University of Lisbon in order to investigate potential experiences with car sharing and the general awareness and acceptance of car sharing in the target market. It was ascertained that car sharing is nearly unknown in the Portuguese population – 59.4 % were not aware of the system – but after a short description the majority is willing to use it.

Furthermore, in addition to the questions concerning personal data, mobility behaviour and car sharing, many ideas of the respondents have been created within the customer research, that can be used for the following development of the final product and service concept.

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Chapter IV

Project Development

20 Project Development

"Thanks to the social web, we can share and trade to use a whole universe of things we once had to buy ourselves. From cars to solar panels, people are realizing they can reap the benefits of ownership without the expense and hassle of buying."

- Lynn Jurich, co-founder and CEO of Sunrun -

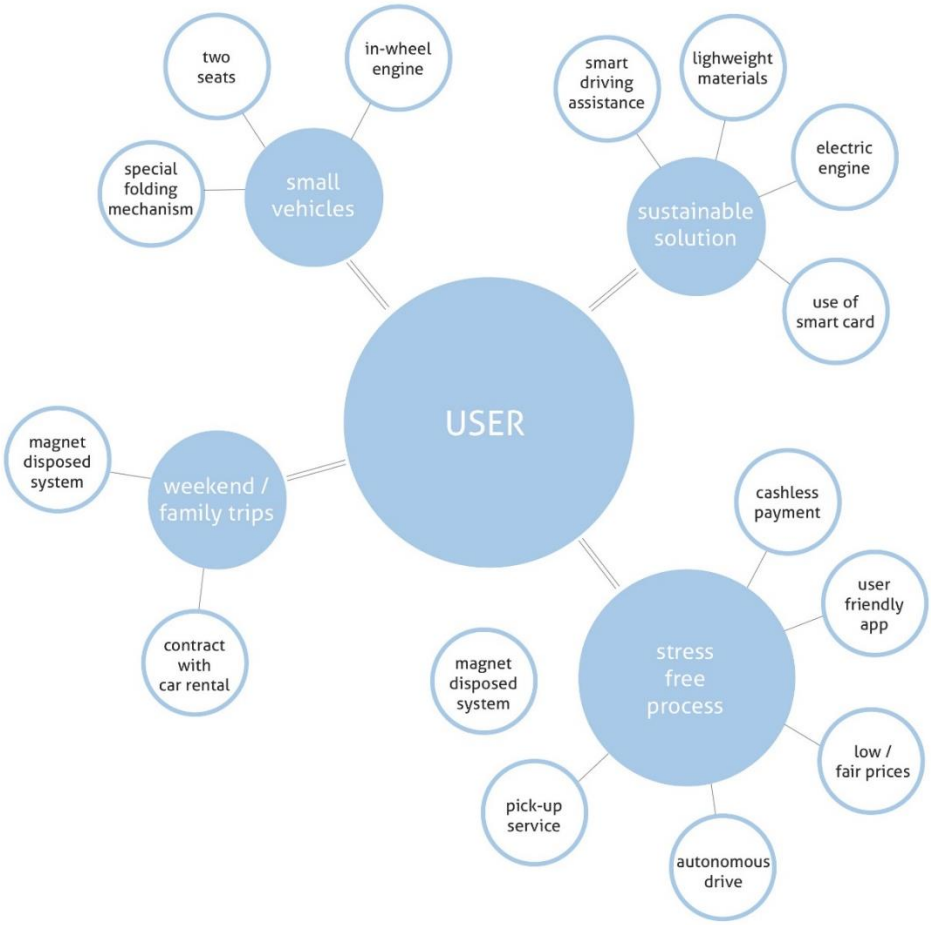
After a thorough investigation of the market conditions and the competitive information, the following chapter represents the presentation of the final product and service concept and therefore builds the main part of this dissertation.

In a first step, a wish list, created in advance, presents the ideas and expectations of a car sharing concept based on the customer analysis, which leads afterwards to the presentation of three different concept ideas. In the second part, the final concept including all technical features and the description of the service operation are introduced before a final evaluation of the concept finalizes this chapter.

20.1 Wish list

After an extensive market analysis, including a direct examination of the potential customer's needs, it is of greater value to first order the needs and wishes in order to be able to develop a car sharing concept for the local market.

Fig. 14: Wish list car sharing (own figure)



As seen in Fig. 14, the user should be in the centre of interest within all the decisions made for a new concept. According to the customer survey, there can be clearly emphasized four main topics, of which the stress free

process stands in the foreground of the customers concerns. In addition, the answers can also be summarized to the wishes of a small vehicle, an overall sustainable solution of the whole product and service concept and the possibility to not only be able to drive within the city centre but also to use the service for weekend trips to the countryside with the family.

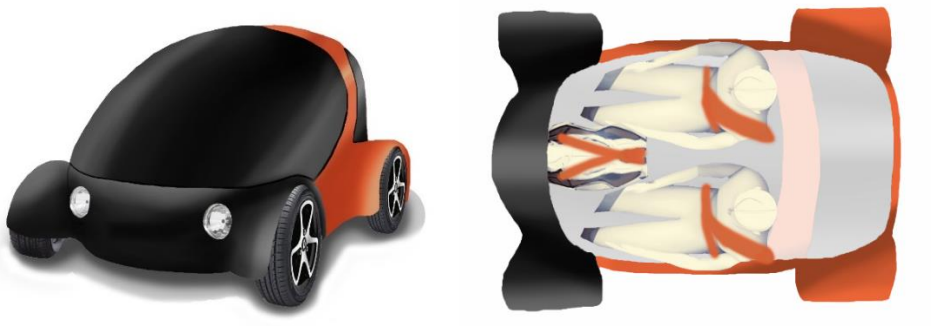
Knowing the prerequisites for a concept to be accepted by the local users, a comprehensive research of technologies and materials provided furthermore first ideas and information about feasible solutions, that can be implemented in the concept (see wish list) and will be further explained in the following chapters.

21 Concept Development

Before exploring the various possibilities of realization of the wishes of the customers and the available technologies, three different types of vehicle architectures have been developed in the first step. As the problem and market analyses already presented, the major share of trips done with a private vehicle is with two persons, the overall size of the vehicle thereupon was adjusted and all three concepts therefore are following the idea of a small city-suitable vehicle. Furthermore, all concepts include the technical possibility of autonomous driving – the vehicle can either be driven manually or autonomously.

21.1 Three Concepts, One Idea

Fig. 15: Concept One (own figure)



When designing Concept One, it has been already clear, that the vehicle should include a large windscreen, enabling the passengers enjoying the view during the trip. This feature was also implemented due to the fact of increasing tourism in Lisbon, leading to the circumstances, that the car

sharing concept can also be used by tourists visiting the city. To ensure the optimum use of the vehicle interior, the wheels are placed outside the vehicle body. Like this, not only further space can be gained and the interior comfort can be increased, but also stable road holding characteristics can be guaranteed. This feature also involves the possibility of a third passenger, a baby or infant, placed in an infant carrier in between the two other passengers.

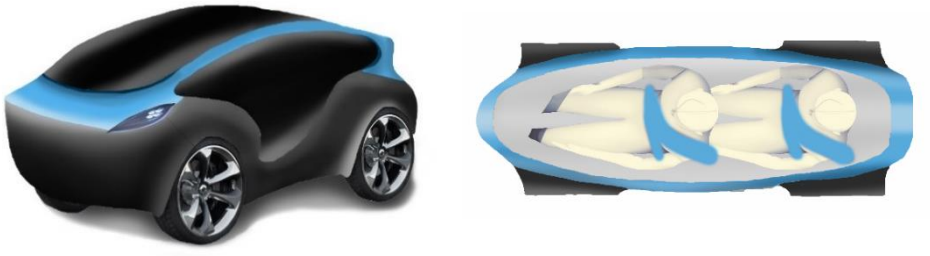


Fig. 16: Concept Two (own figure)

Concept Two on the contrary to Concept One, represents a sporty version of car sharing. The passengers are placed in a row, the back seat however can also be pulled back, allowing the front seat rotating by 180 ° and the front passenger to drive alone. This concept was designed, having in mind the local conditions such as the small and narrow streets in the city centre and old towns.

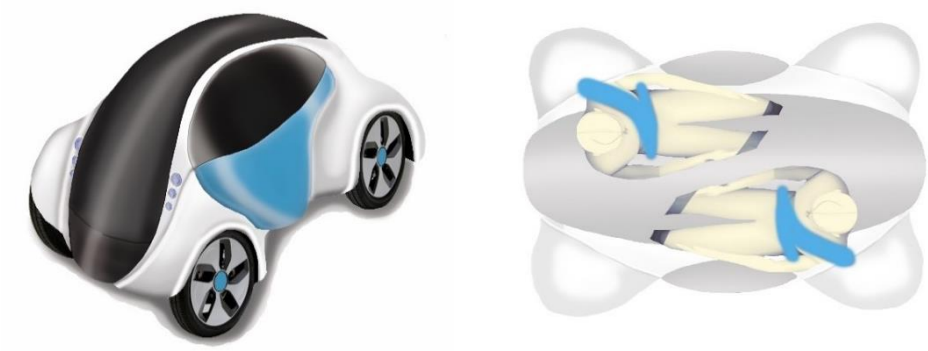


Fig. 17: Concept Three (own figure)

Within the design stage of Concept Three, a complete new idea of vehicle architecture and appearance was created. The different features of the two concepts developed beforehand are combined within Concept Three. On one hand, the vehicle interior provides sufficient space for two people and some luggage, due to the outside placement of the wheels. On the other hand, following the idea of Concept Two, both seats can be turned by 180 °, enabling the passengers to talk to each other during an autonomously ride. Furthermore, the large windscreen extending the whole vehicle roof, provides an all-round visibility as well as a bright interior. The symmetric design of the vehicle and the possibility to turn both seats, makes it furthermore possible to drive in both directions.

21.2 Concept Decision Making

All the three previously presented concepts for a car sharing vehicle represent the requirements of potential customers, according to the online survey conducted within this dissertation. To decide, which of the concepts to choose for a further development, a modified version of the C-Box matrix is used within the following.

Based on the two criteria innovativeness and feasibility, the concepts are rated using a 2 x 2 matrix. The x-axis thereby represents the innovativeness – "familiar ideas are at one end, highly innovative ones at the other end" (van Boeijen et al., 2013, p. 143), the y-axis the suitability – one end is not suitable for Lisbon, the other end represents a very high city suitability. The factors influencing the suitability are mainly based on the users' needs, such as the size of the vehicle and whether it constitutes to an easy and stress free process or not. After placing every concept in the C-Box, the most promising one in terms of high innovativeness and city suitability will be used for the development within this dissertation.

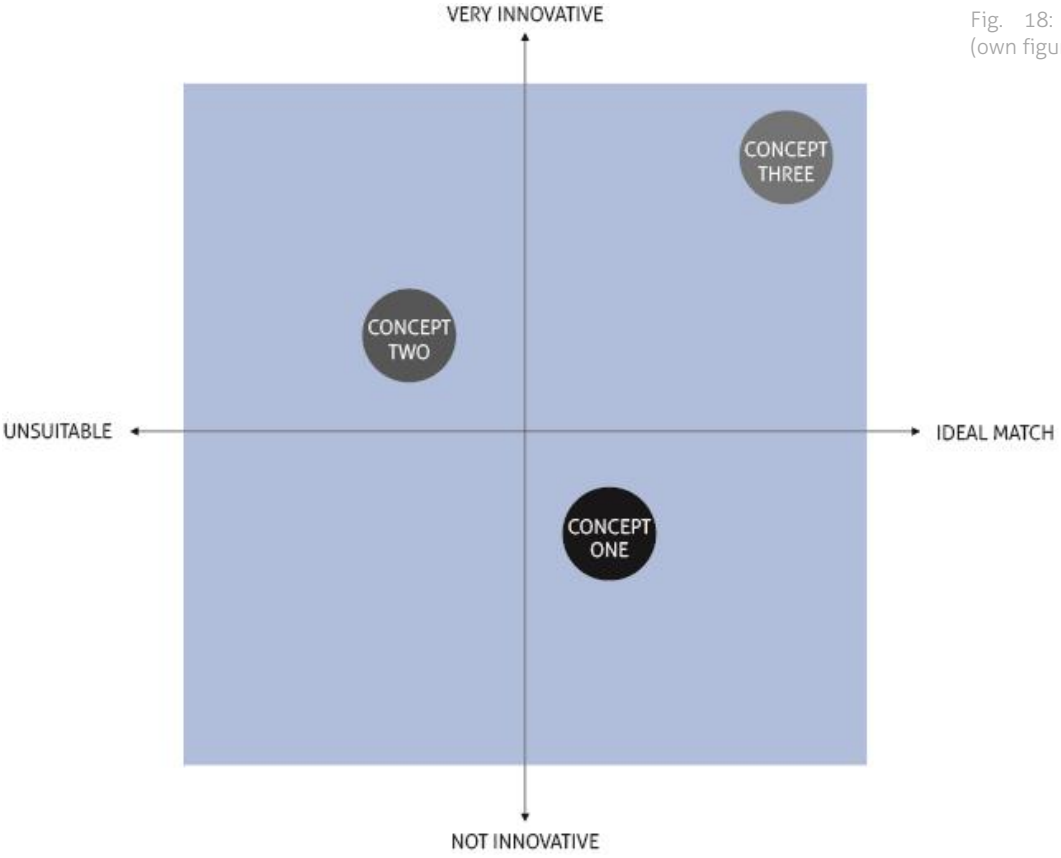


Fig. 18: C-Box matrix (own figure)

As seen in Figure 18, Concept Three can be rated by far as the most suitable and most innovative concept. In comparison with all three concepts, it represents the most innovative idea in terms of shape and interior design. Due to its small and compact size it further offers the highest city suitability, fitting the local needs of Greater Lisbon. Therefore, Concept Three has been chosen for the development of a car sharing concept and will be described in the following chapters.

22 The LX Drive Car Sharing Concept

22.1 Design Evolution Process

The LX Drive car sharing concept was created based on the idea of improving the cities' attractiveness in terms of reducing traffic overload and air pollution and to establish a new way of mobility, designed for the special needs of Lisbon. LX Drive combines the newest technologies, the most sustainable material solutions and a user-friendly service procedure with a unique and special appearance, in order to attract many citizens to start the sharing community in Portugal's capital city Lisbon. LX Drive is a new way of a public transport system based on the ideas of existing car sharing systems all over the world, having all in common the shared use of a fleet of modern and practical vehicles. To encourage Lisbon's citizens to start sharing, the vehicles of LX Drive have an extraordinary and simple design, with a high recognition value and an easy handling promise.

As already stated in the chapter of concept development, the vehicle includes two passenger seats, possessing the ability of turning into both directions of travel. Driven either autonomously or manual, the passengers are able to decide whether they take over control or have a conversation during the ride. Furthermore, in order to create a comfortable and secure feeling while driving the car, the vehicle body and thus also the vehicle interior is created as a "safety capsule" like a cocoon (see Figure 19 and Figure 20).

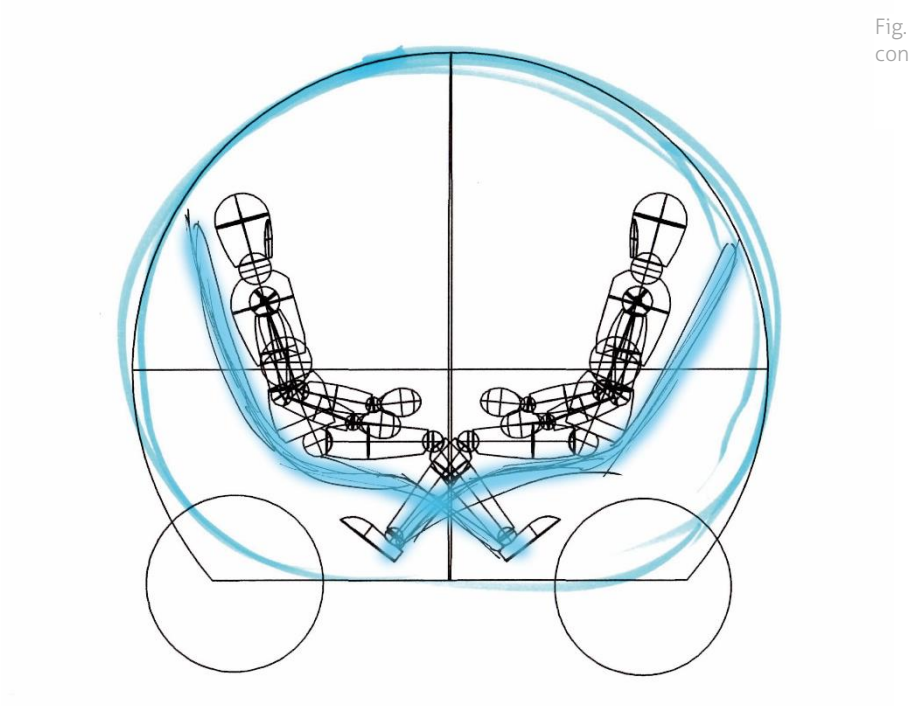


Fig. 19: Vehicle body concept (own figure)

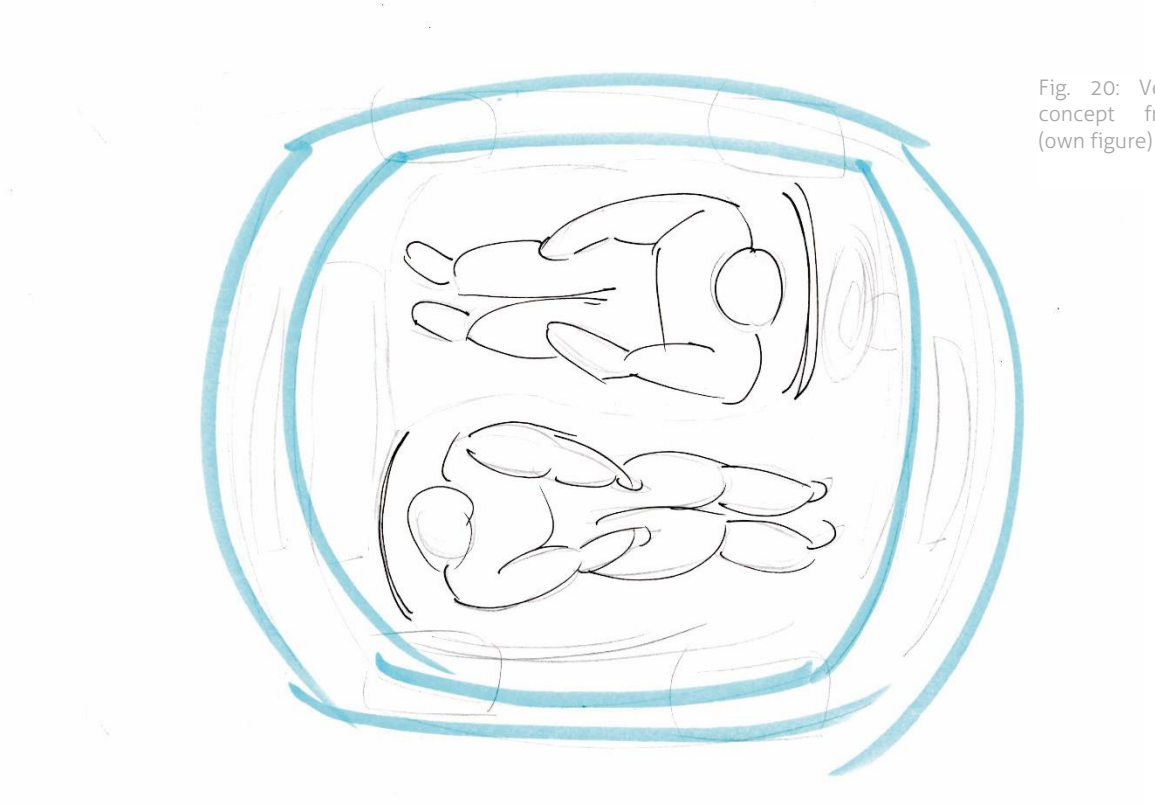


Fig. 20: Vehicle body concept from above (own figure)

The goal of the design stage was it to create a sophisticated and appealing vehicle, attracting as many citizens as possible. Therefore, the *Volkswagen Käfer* was used as a model in the further steps of designing the exterior. With its unique design and its rounded shapes, it forms the perfect basis for the creation of a shell to cover the driver's cabin.

Fig. 21: Volkswagen Käfer (Classic Autoglas, 2014, n.p.)

By looking at the main design characteristics, especially the wheel cases and the slightly sloping back are noticeable, which have been taken into consideration for the LX Drive vehicle.

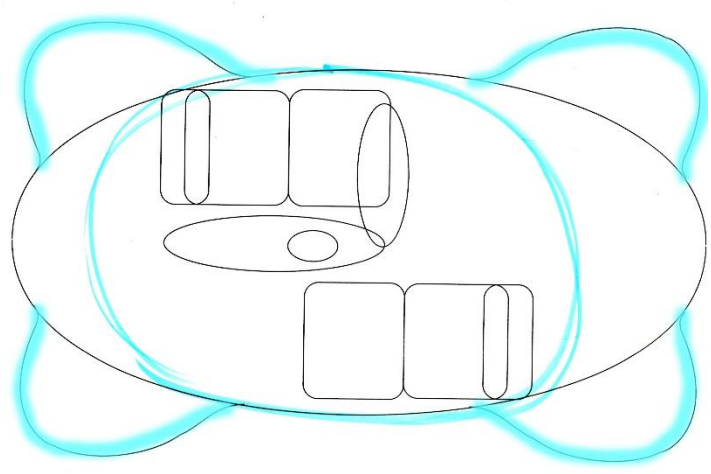


Fig. 22: Wheel cases design (own figure)

As already described, when placing the wheels slightly outside the vehicle body, not only the interior space can be increased but also the stable road holding characteristics can be guaranteed. Thus, Figure 22 shows a draft version of the vehicle design in a top view, already including the wheel cases outside the body.

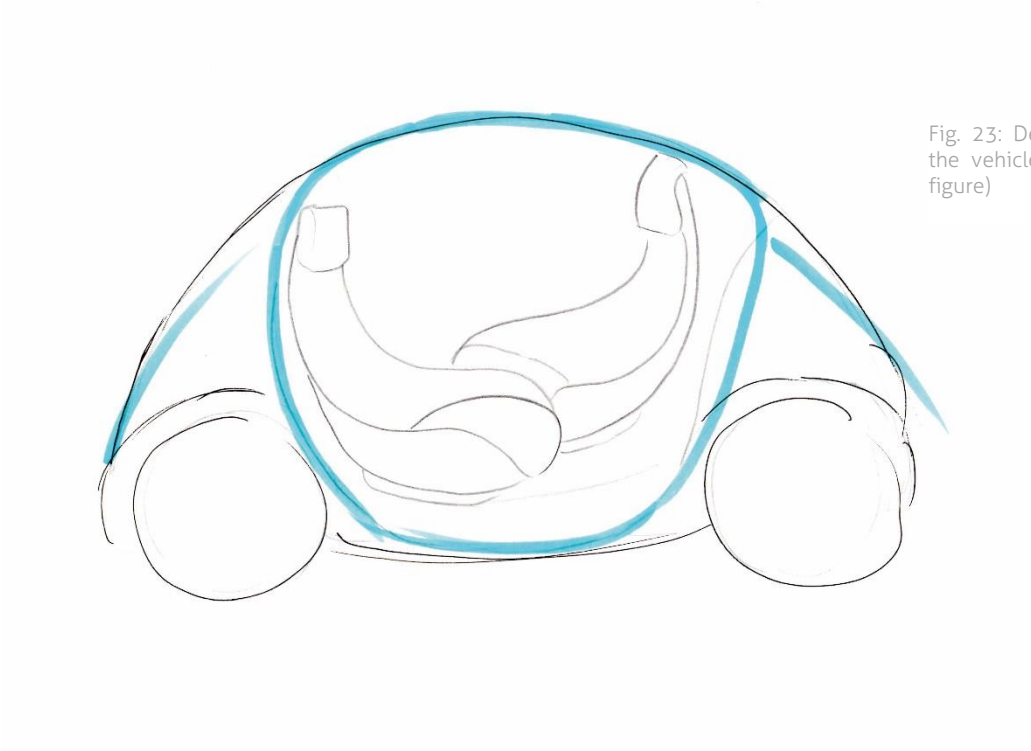


Fig. 23: Design draft of the vehicle shape (own figure)

Figure 23 furthermore shows the combination of both features, the sloping back and the wheel cases in a first design draft of the vehicle shape. In order to create a symmetric and more attractive design, the back as well as the front are designed similar to each other.

22.2 Final Vehicle Design

Fig. 24: LX Drive final design (own figure)

In the style of the famous classic *Volkswagen Käfer*, the final design of the LX Drive car sharing vehicle is kept as simple as possible in order to attract many potential customers within the Lisbon area. On one hand, it has an innovative and unique look with a high recognition value, on the other hand its symmetric and simple shape ensures an easy and flexible handling.

The vehicle has a length of 2,860 mm in total – in comparison, the smart fortwo has a total length of 2,695 mm (smart, 2016, n.p.) – and is therefore the perfect city car, fitting even into the smallest parking spaces. Furthermore, its symmetric shape combined with the autonomous driving enables the driver to choose the driving direction, which is also a supporting feature when parking. As the vehicle shall also be used by tourists visiting the city, the whole roof comprising panoramic windscreen allows the passengers to enjoy a 180 ° view during the ride to enjoy all the beautiful sides of Lisbon.

22.3 Vehicle Concept – Technical Specifications

In order to reduce the inner-city traffic problems, such as air pollution, and to contribute to a more sustainable city environment, the vehicle is operated by electricity. Furthermore, it includes many technical and sustainable features, that will be presented in the following.

22.3.1 Vehicle Interior Layout

As already described, the vehicle comprises one main feature, the autonomous drive, what allows the passengers to travel with a high level of comfort. According to the problem analysis in chapter 2, the major share of car trips is done by one to two person. In conclusion, the vehicle includes two passenger seats, which can be turned by 360°, enabling the passengers to travel either with or against the driving direction and to face each other during the ride to have a conversation (compare Figure 25 and Figure 26).

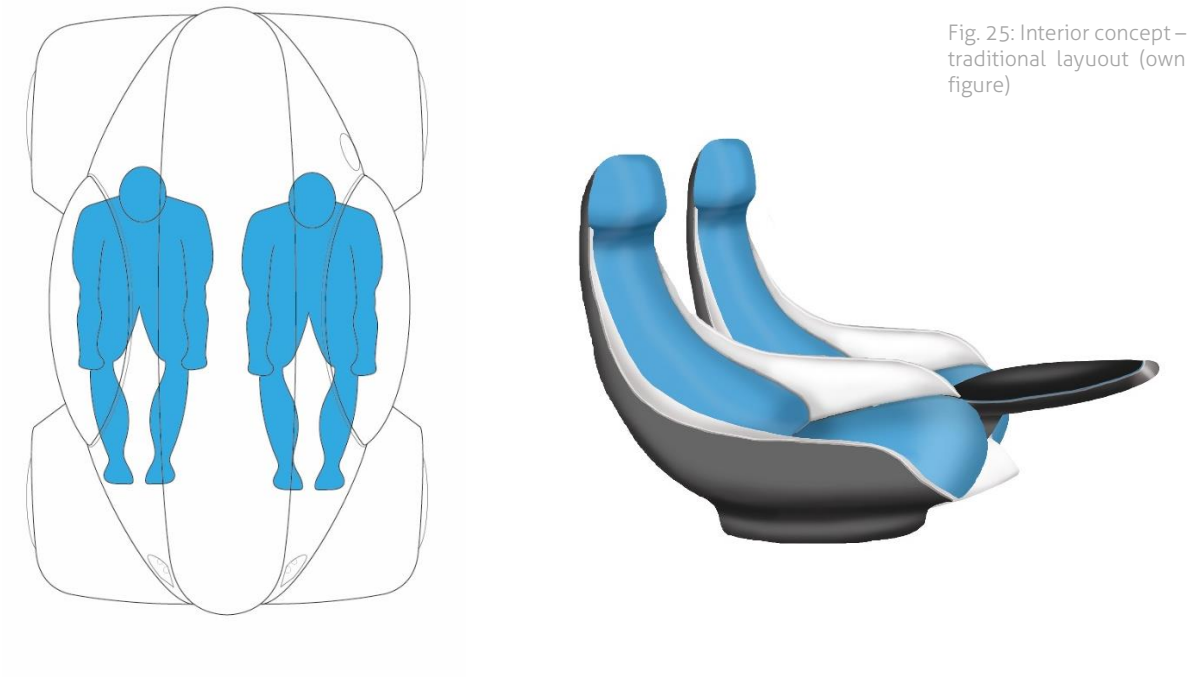


Fig. 25: Interior concept – traditional layuout (own figure)

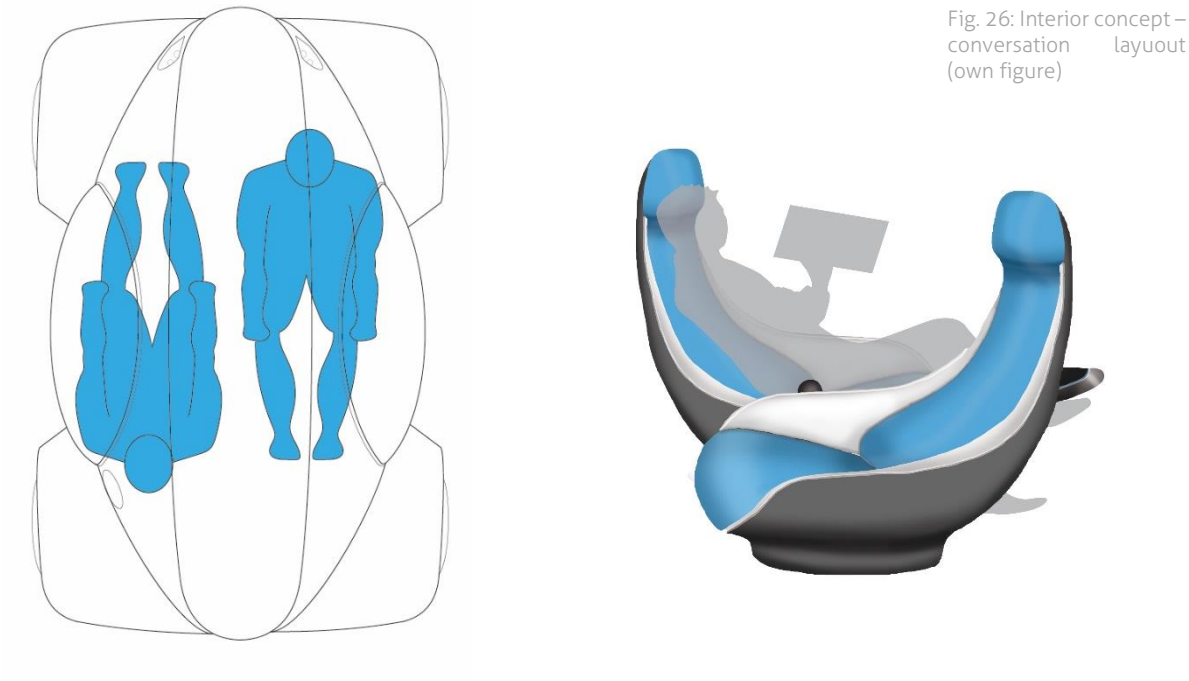


Fig. 26: Interior concept – conversation layuout (own figure)

Unlike a traditional car, the LX Drive vehicle does not consist of the classical dashboard and wheel composition in the interior front. In point of fact, the interior concept follows the approach of simplicity used also for the exterior design. Next to the turning passenger seats and in between those, a center console is placed, including a touchpad, providing a street map and further vehicle information as well as a joystick in order to enable the passengers to take over control and to drive the car manually if necessary. The position of the two seats in the vehicle allows the passengers to place a small amount of baggage, as for example purchases or small suitcases, either in front or behind the seat. Furthermore, two cup holders in the center console offer space for drinks or small devices, such as smartphones or keys.

Fig. 27: Interior concept (own figure)

22.3.2 Technologies

Zero emission and zero noise – these were the main concerns, when developing vehicle concept. After a comprehensive research of new and future technologies, ensuring also these two criteria, three main features stood out, that fit the local conditions and help contributing to a more sustainable and pleasant urban landscape.

The vehicle is powered electrically by four small engines, placed in the wheels behind the 16 inch rims. Each wheel power unit provides 40 kW, which relates to a continuous output of 33 kW. With the in-wheel engines designed by the Schaeffler AG, the components required for drive, deceleration and driver assistance technologies are installed in an integrated wheel hub drive including the electric motor, braking and cooling systems (Schaeffler, 2013, n.p.).

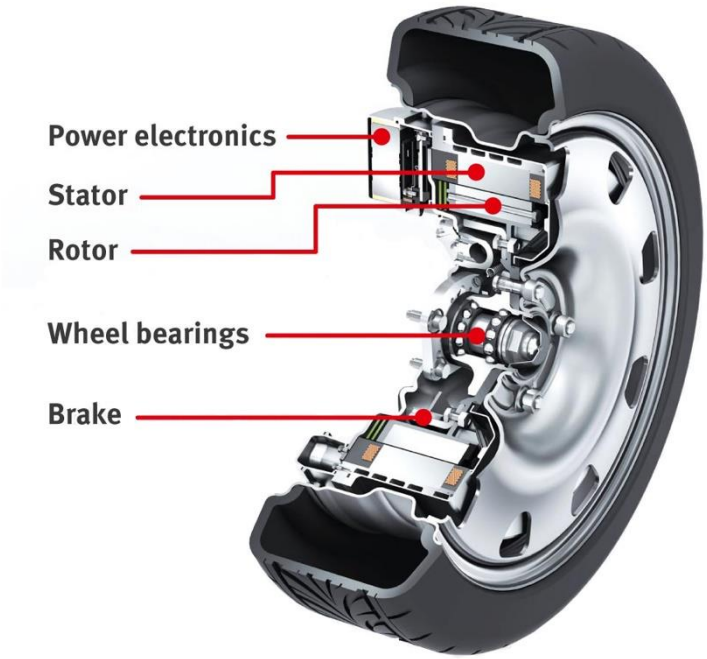


Fig. 28: In-wheel engine (Schaeffler, 2013, n.p.)

90° Steering Angle

Directly connected to the in-wheel engines is the feature of sideways driving. In order to ensure the high flexibility of driving normal and diagonal, to turn on the spot and to drive sideways, the vehicle has a 90° steering angle at the front and rear axle. This technical feature was first developed and introduced by the DFKI GmbH and the University of Bremen Robotics Innovation Centre in Germany (Mehmed Yüksel, 2016, n.p.).

Fig. 29: 90° steering angle (own figure)

Magnetic Supposed Docking System

A further special technology applied to the LX Drive car sharing vehicle, was also first introduced by the DFKI GmbH and the University of Bremen Robotics Innovation Centre. A magnetic docking system allows several vehicles to connect each other not only while driving, but also when parked.

Simple wireless energy transfer combined with a magnetic system facilitates two or more vehicles to charge one another and to share energy (Mehmed Yüksel, 2016, n.p.)

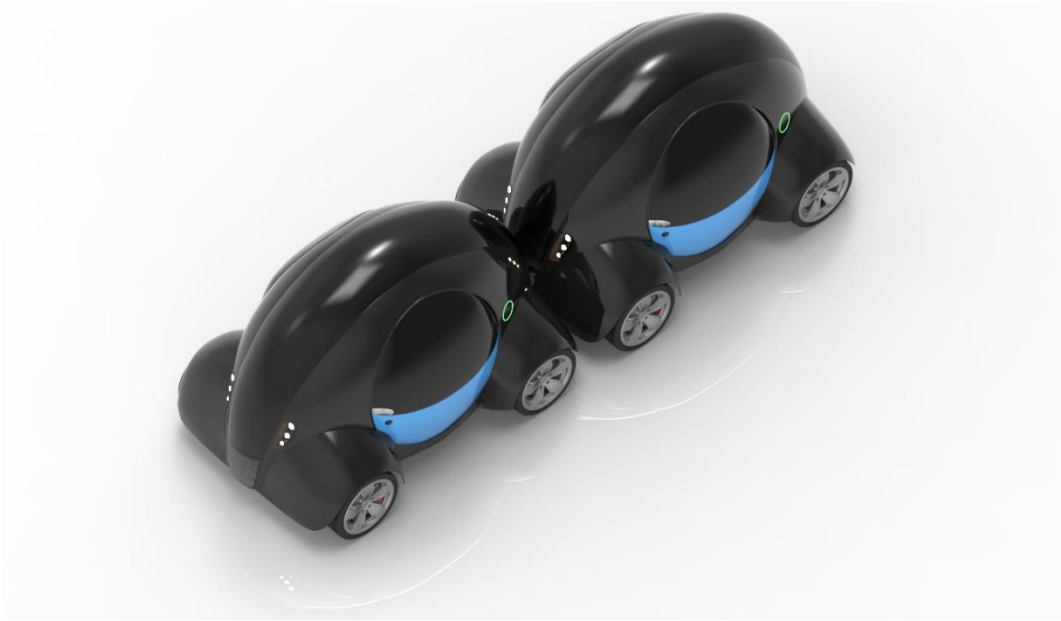


Fig. 30: Magnetic docking system (own figure)

Electric Range Colour System

The range colour system is a small gadget, helping the driver to recognize when the vehicle needs to be charged and if a vehicle has enough energy to be rent. A light indicator integrated in the charging socket shows the battery status, ranging from green (fully charged) to red (minimum range).

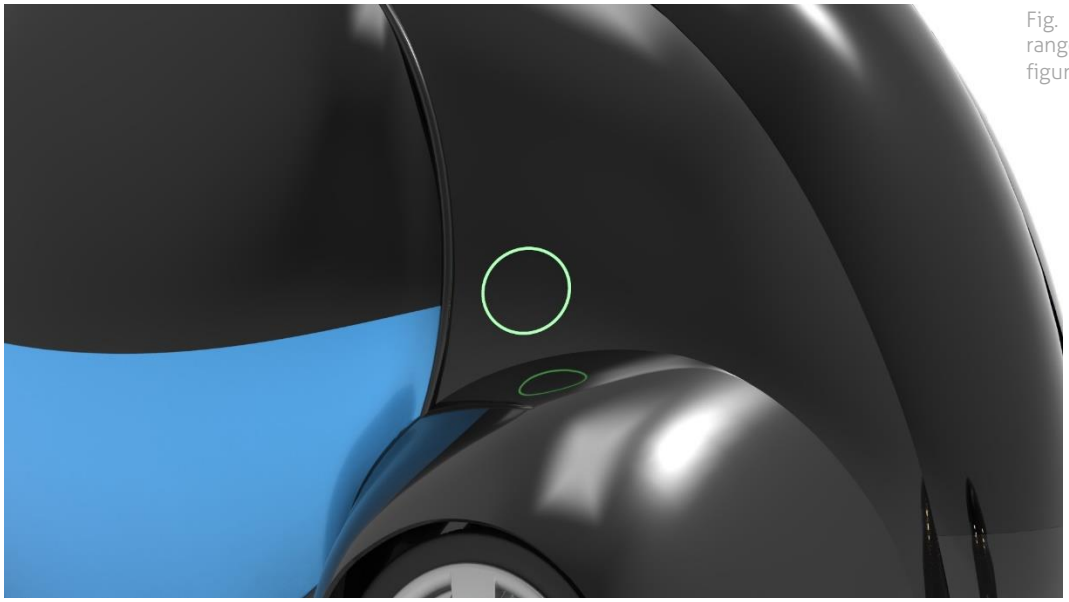


Fig. 31: Electric colour range system (own figure)

RFID / NFC – keyless opening

In order to ensure a smooth operation during the rent, in particular when taking and returning the vehicle, the RFID technology allows the user a keyless entry system. RFID – radio-frequency identification – is a technology for transceiver systems for automatic, contactless identification and localization of objects with radio waves. An RFID system consists of a transponder located on or in one object, including an identifying code, and a reader that is able to read this code. In the case of the car sharing system these two components appear in the form of the smart phone or member card and a reader located in the vehicle window. The exact technology used for the LX Drive car sharing is called NFC (Near Field Communication) and is based on the RFID technology for short distances of a few centimetres (Kitsos and Zhang, 2009, p. 61).

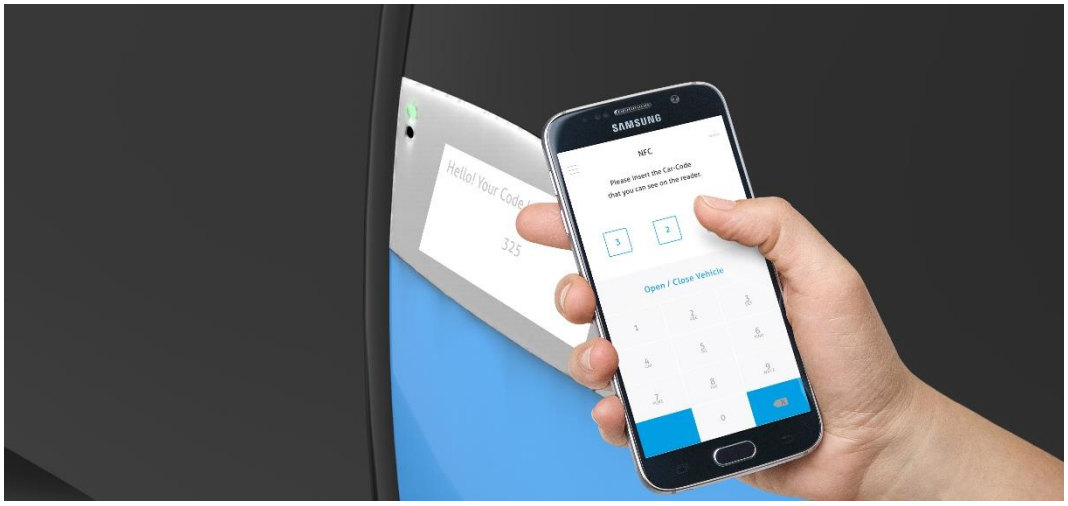


Fig. 32: NFC (own figure)

22.4 Service Strategy

According to Manzini and Vezzoli (2001), a product service system can be defined as "an innovation strategy, shifting the business focus from designing (and selling) physical products only, to designing (and selling) a system of products and services which are jointly capable of fulfilling specific client demands" (Manzini and Vezzoli, 2003, p.1). Especially when designing a new car sharing system, which comes directly under the definition of a classical product service system, it is indispensable to develop an extensive service concept to focus on meeting the users' demand. However, as users do not really demand the product per se, in this particular case above all, but what they are able to achieve with it, the main target of a car sharing system is it to meet the customers' satisfaction. And if the satisfaction consequently was realized, customers will preferably use this very service.

The service concept, developed within the scope of the dissertation, is based on a free-floating system of electric vehicles within the Lisbon area. With a free-floating car sharing system the customers are able to pick up and return the vehicles at any place within a predefined service area

without any extra charges for parking spots. When a user desires to charge the vehicle, in order to receive a 10 minutes free riding bonus on the customer's account, it is possible to use one of the many charging points of Mobi.E, allocated all over the city.

Furthermore, as this concept is based on an autonomous system, unplugged, fully charged vehicles can be ordered to pick up the customer at his current location. Like this, users can use the car sharing more freely in order to plan and organize all trips they do.

22.4.1 Service Area

As already stated, the car sharing service is operating within a defined service area. Vehicles can be rent, used and returned within a predetermined area without any extra fees, in order to ensure a constant availability of the service for the users.

Rental Zones

Fig. 33: Service Area (own figure)

As can be seen from Figure 33, the area is further divided into two main areas, covering Great Lisbon. Within the "green zone" covering Lisbon including the densely populated areas Amadora, Odivelas and Parque das Nações, vehicles can be parked without any extra charge. This area was selected based on the information of population density, charging infrastructure, subway connection and the online survey, conducted within the market study.

Population density Lisbon area "green zone":

Table 04: Population density Lisbon area (INE, 2013)

	Population density (No. / km^2)	Population (No.)	Area (km^2)
Amadora	7,397.7	175,136	23.7
Odivelas	5,758.1	144,549	25.1
Lisbon	5,090.4	547,733	107.6
Oeiras	3,769.6	172,120	45.7
Cascais	2,149.6	206,479	96.1
Loures	1,224.0	205,054	167.5
Sintra	1,193.3	377,835	316.6
Vila France de Xira	439.7	136,886	311.3
Mafra	278.4	76,685	275.4

In addition to the "green zone", another zone covers the area of Greater Lisbon including also Oeiras, Cascais, Loures, Sintra, Vila Franca de Xira and Mafra. In this "yellow zone" customers are allowed to travel and park the vehicles, having in mind however, that an extra fee of 10 € is charged, when the car is not in use longer than 12 hours.

Number of Vehicles

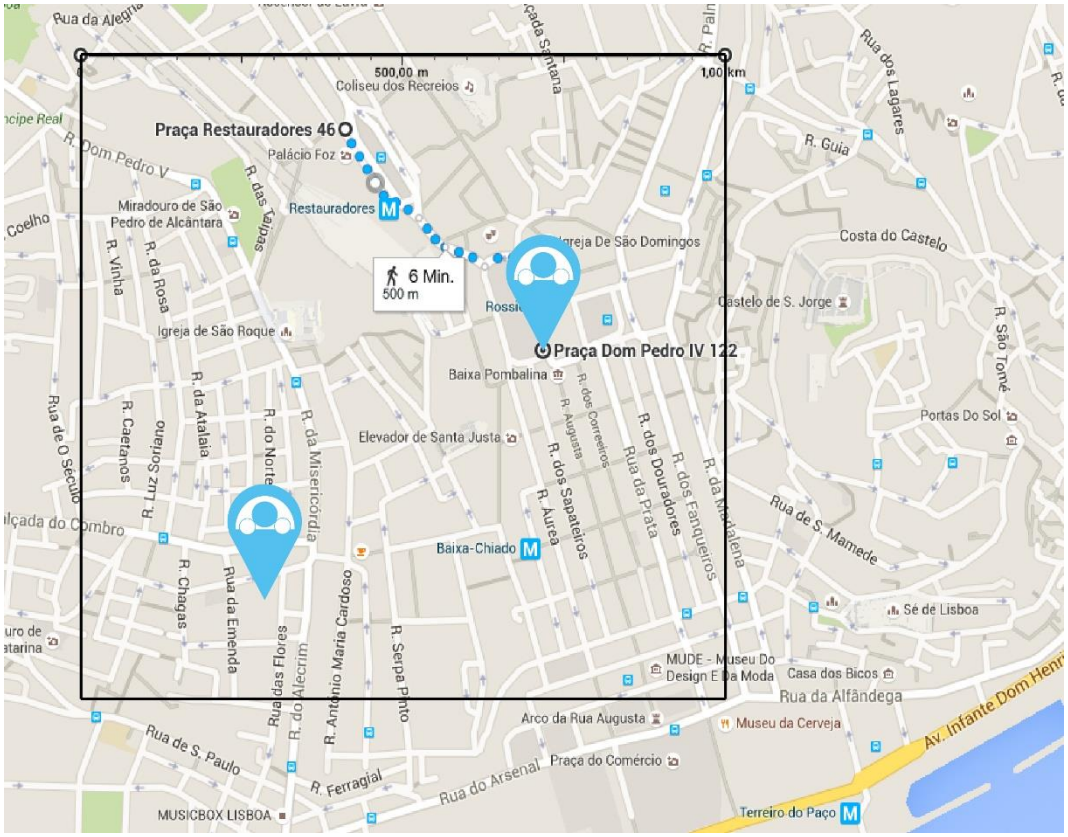


Fig. 34: Amount of vehicles (own figure)

An additional important consideration when developing a car sharing concept is the definition of the amount of vehicles that is necessary to cover the demand of the customers. According to the online survey, on average, respondents are willing to walk between 1-10 minutes to a car sharing location in order to pick up a car (57.4 %). Based on this information an online research, using the maps tool Google Maps, resulted

consequently in a walking distance of 500 meters and an average time of walking of 6 minutes. Within a square of 1 km^2, therefore, two vehicles seem to be the appropriate amount to serve as a calculation base for defining the number of cars within the main area (Figure 34).

Following from this, the calculation for the "green zone", Amadora, Odivelas and Lisbon, results in approximately 300 vehicles.

$$\begin{aligned} &Amount\ of\ vehicles \\ &= (23.7\ km^2 + 25.1\ km^2 + 107.6\ km^2) * 2\ vehicles\ per\ km^2 \\ &= 312.8\ vehicles \end{aligned}$$

It is furthermore suggested, that this calculated amount will be reached step by step, in order to ensure the full utilisation of the service.

22.4.2 Rental Transaction

After defining the service area, in which the car sharing is operating, and a calculation of vehicles that are necessary to cover the market, this chapter targets on the description of the rental transaction from finding a car over usage and end of the sharing period.

Registration process

To be able to use the service of LX Drive car sharing, the first step for the customer is it to undergo a defined registration process. In the course of this, users have to log in on the website of the provider and to deposit name, address and age. The following step provide for a verification of the European driving license and the personal data at one of the service check points that are dispersed over the city. After the official confirmation of all data, the user receives a smart card, including a RFID chip that enables him to access, open and close the previously booked vehicle. For this process, the user can also use the smartphone application.

Find a car

All information concerning vehicles are stored in one system, on which the users can directly access in order to rent a vehicle and to review their financial situation by logging into their own account. The user can search available cars on an interactive map either on an online website or with the help of the smartphone application. By selecting one vehicle on the map all information, such as registration number, current location and battery range appear in a separate window (see Figure 35).

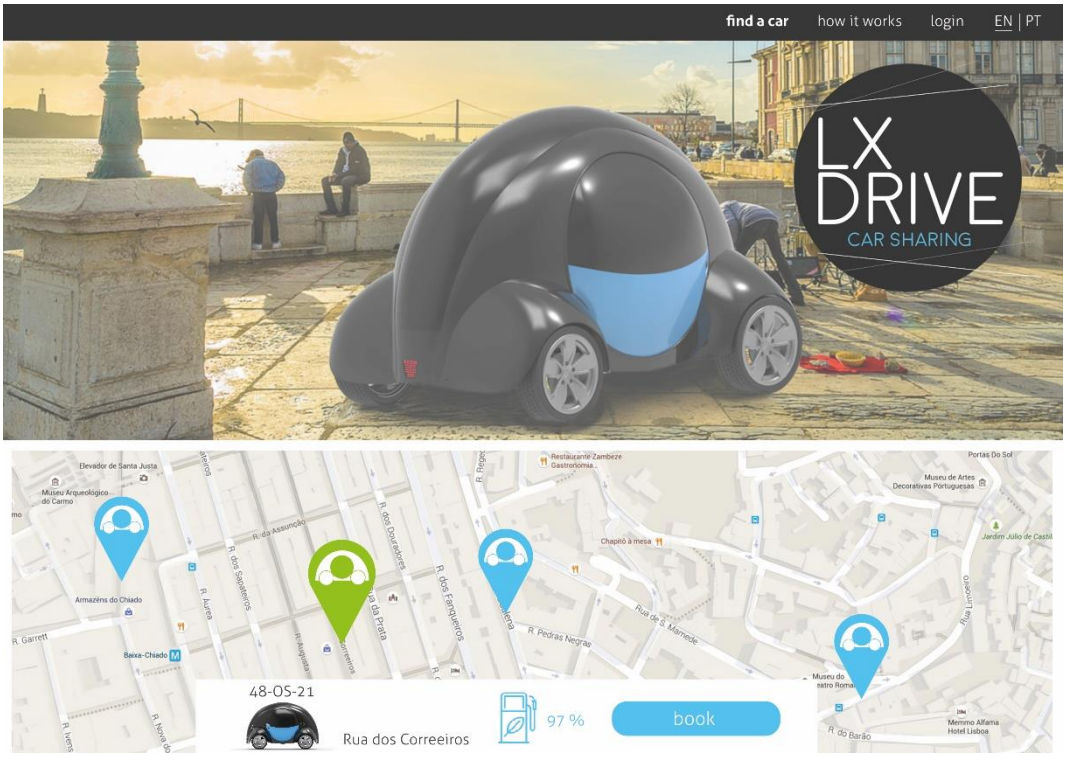


Fig. 35: Website search a car (own figure)

In order to subsequently make a reservation, the customer needs to book the car. This reservation is valid for 30 minutes after the confirmation – upon expiration of this period, the entitlement will lapse and the reservation needs to be repeated. A further feature enables the customer to order a vehicle, using his smartphone application, in order to be picked up at any location within the service area. In conjunction with the

application further possibilities of ordering and booking are possible, which will be described in the following chapter.

22.4.3 Smartphone Application

As already stated, vehicles can be booked either on the provider's website or with a smartphone application, that has been designed within the scope of this dissertation.

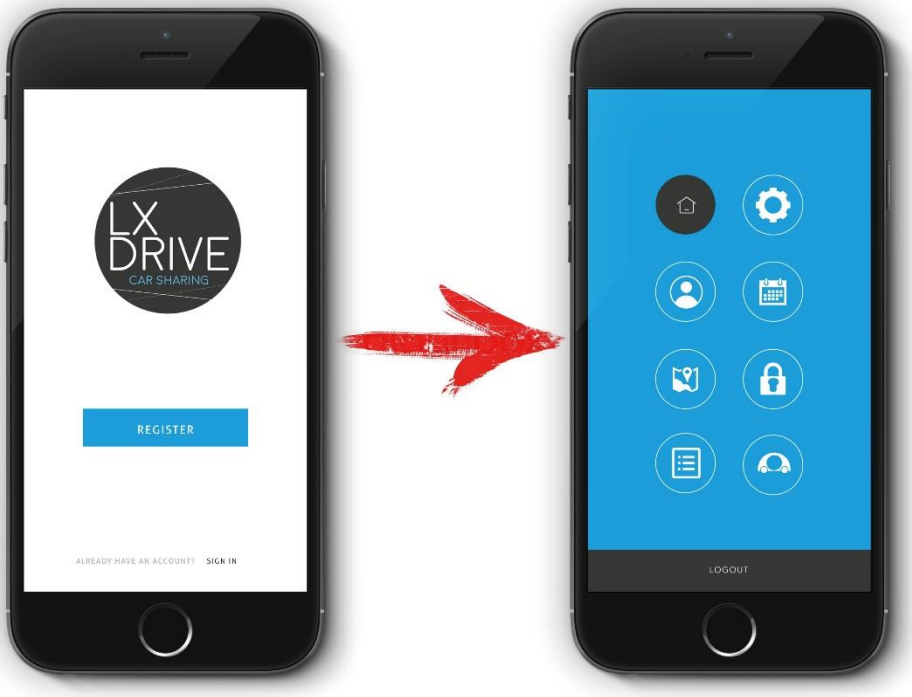


Fig. 36: Website search a car (own figure)

The clean and simple design used for the vehicle is also reflected in the design of the application. Users can download the app, register and are then able to use for the complete renting process. As seen in Figure 36, the menu is divided into eight sub categories – Menu, Settings, Personal information, Calendar, Map, NFC, Cost overview and Vehicle information. The exact description of each category is discussed in the following.

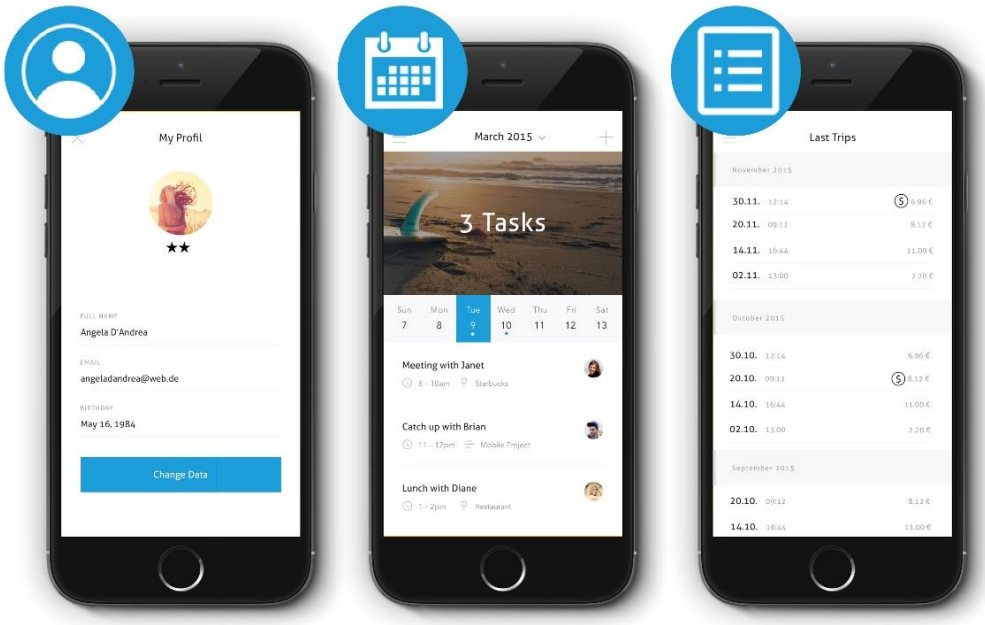


Fig. 37: Calendar (own figure)

Every user can create a personalized account in which information, such as e-mail address and birth date can be saved. Furthermore, using a calendar, trips can be easily organized in order to keep up to date with meetings and appointments. A further feature enables the user to review every single trip done in the last months, including date, route, costs and bonus payments. The latter of these is depending on whether a vehicle will be returned to the charging stations, and plugged in, or not. Bonus payments can be granted within a special bonus system, which is based on a station based concept. In general, users are free to park the vehicles at any place in the city. On the other hand, they can return vehicles at one of the Mobi.E charging stations, distributed all over the city, in order to receive 10 minutes free riding on their own account.

In parallel to the possibility of booking vehicles online on the website of the provider, cars can either be reserved or ordered using the smartphone application. Vehicles, which are fully loaded and ready to pick up the customer are marked with two black stars on the map and within the

vehicles specifications. The user can independently decide, whether he would like to be picked up, for a higher price, or to do a simple reservation and walk to the car (see Fig 38 38).

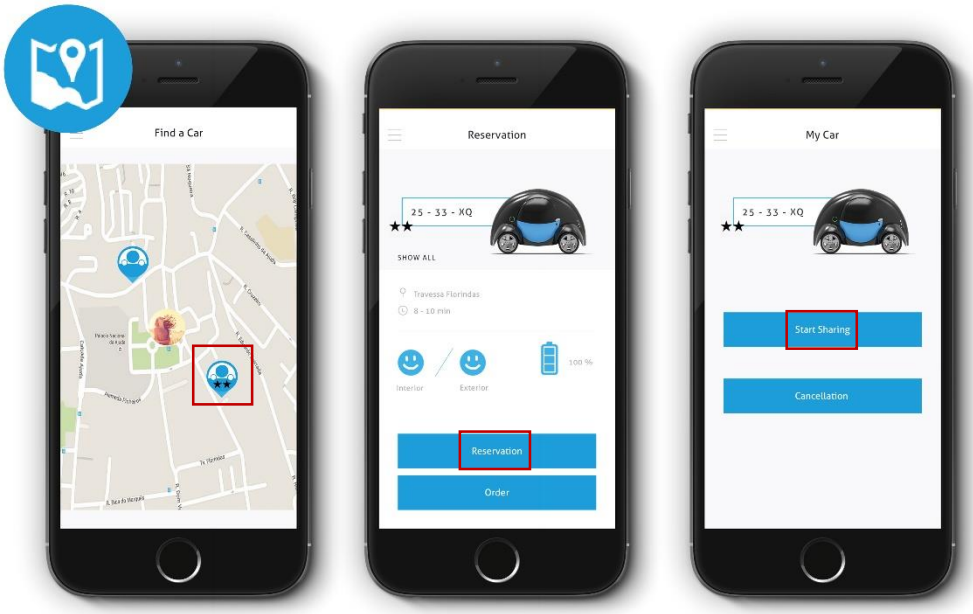
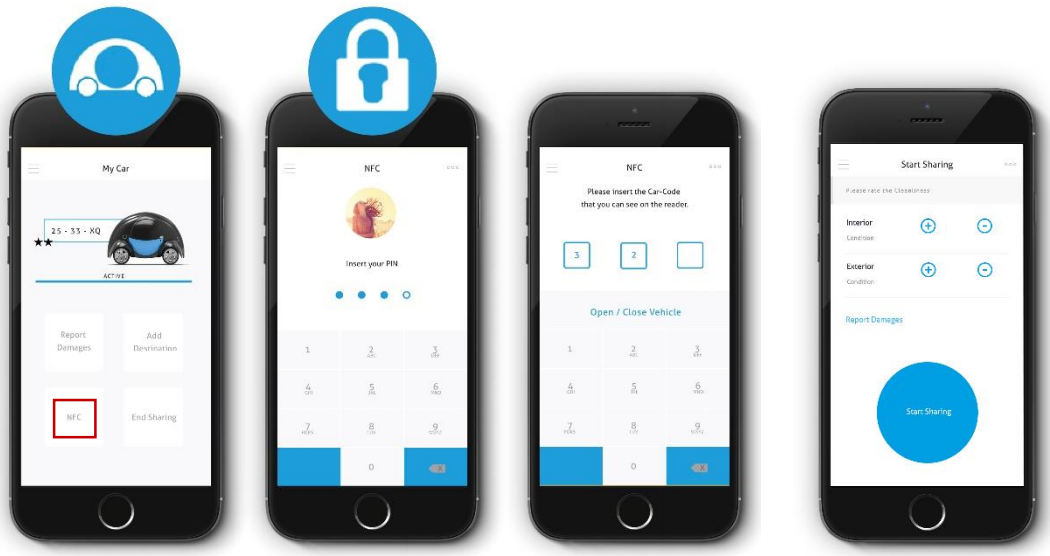


Fig. 38: Search a vehicle (own figure)

The process of receiving and opening the vehicle can be seen in Figure 39. Before a flawless use and the start of the vehicle can be provided, the user needs to confirm the acceptance of the car by evaluating the condition of the interior and exterior space. With the help of the application the customer can rate any damages, that can be found when entering the vehicle and examining it from the outside. Like this, fully security can be ensured for each user with regard to vehicle assurances.

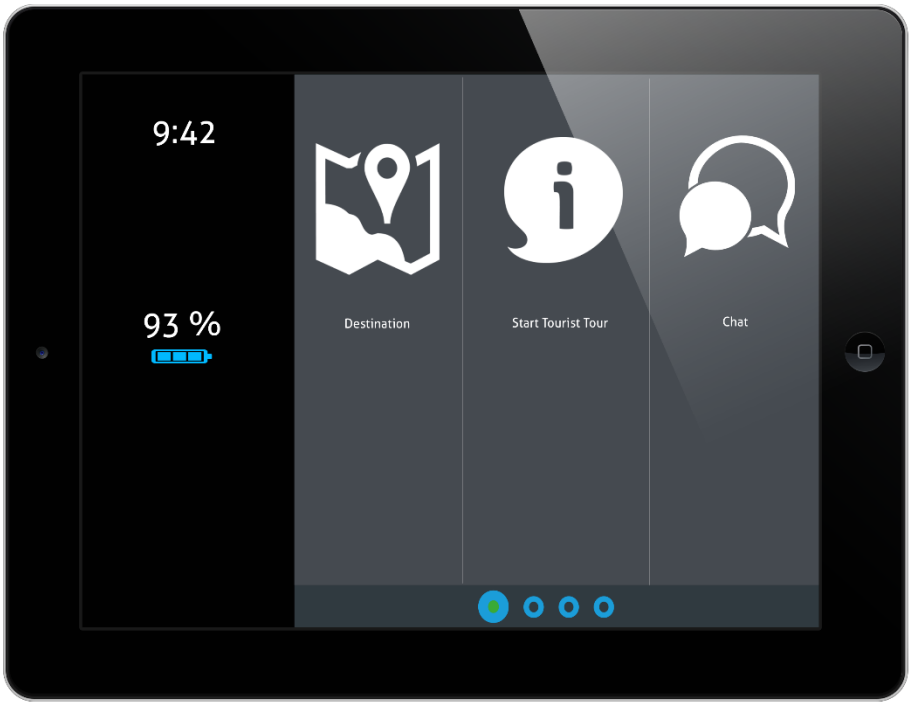
Fig. 39: Opening the vehicle (own figure)



22.4.4 User Interface Interior

The infotainment and the interior user interface design plays a further important role in the development of a sustainable car sharing concept. Especially in consideration with the features of docking with other vehicles and choosing destinations in autonomous mode, an intuitive infotainment can provide a pleasant atmosphere in during the ride. As described in chapter 21.3.1, the interior of the vehicle is kept as simple as possible in order to meet this prerequisite. Besides the two seats and a joystick, the interior is composed of one visual display unit in the center console, with which all the necessary settings can be done easily from both drivers.

Fig. 40: Home screen infotainment (own figure)



The home screen and the complete infotainment comprises three groups:

- Choose the destination with the help of a map:

  Here the driver can decide, where to go and whether he would like to activate the docking mode or not. In the docking mode the vehicle occupants are able to also chat with other vehicles in the surrounding area in order to facilitate the docking. When vehicles are docked, energy can be shared among two cars.

- Start tourist trip:
  Another feature, coming with the car sharing service, is the possibility to use the vehicle for tourist tours. Therefore, the driver only needs to activate a special tourist program. According to that, the car is driving to all the tourist hotspots in the town, explaining all the important information on the way.

- Chat:
  In order to have a chat with other cars, the docking mode needs to be activated in the forefront. Subsequently, occupants of different cars are able to chat during the ride.

22.5 Evaluation of the Concept

Within the last phase of the project development, it is of great importance to evaluate the concept.

In this stage, the developed product concept is evaluated quantitatively, using again the criteria of the idea evaluation in order to evaluate the mature product ideas and completing those with the verified information from the idea detailing. The formulated and detailed product innovation ideas are also evaluated with regard to its technical and esthetical feasibility.

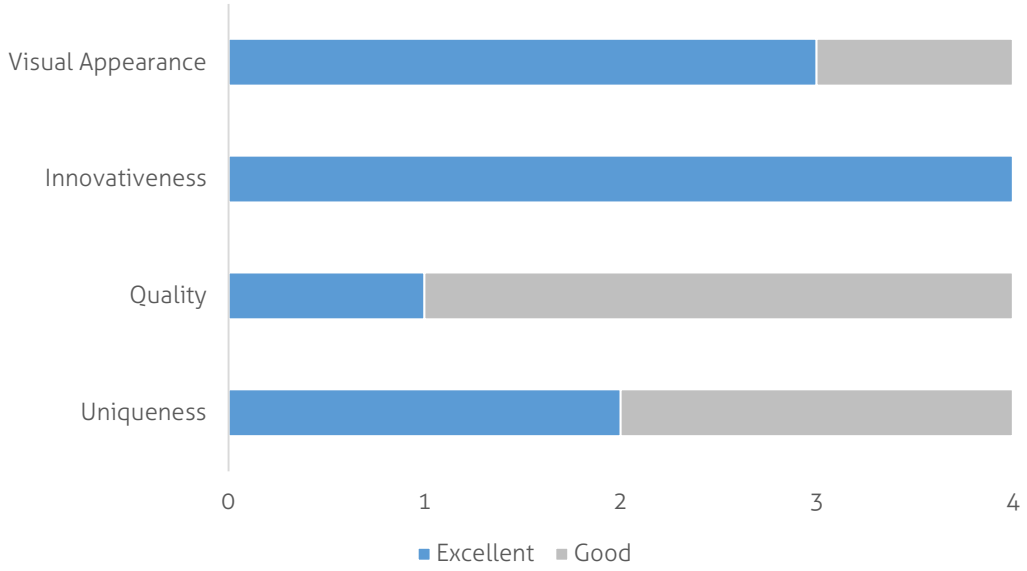
22.5.1 Panel of Expert

For the purpose of the concept evaluation, a special document was created and sent to a selection of four different experts, of which each of them represents a specialist on their fields in engineering or sustainability (see Annex 5). The document comprises short descriptions of the product and its technical features as well as an extensive characterization of the service and the interconnection of both in one product-service system. With the help of 10 questions, the experts where able to evaluate the concept with regard to its product and service specifications. Furthermore, they were asked to shortly describe the disadvantages and advantages of the concept, using their specialist experience.

Product Specifications

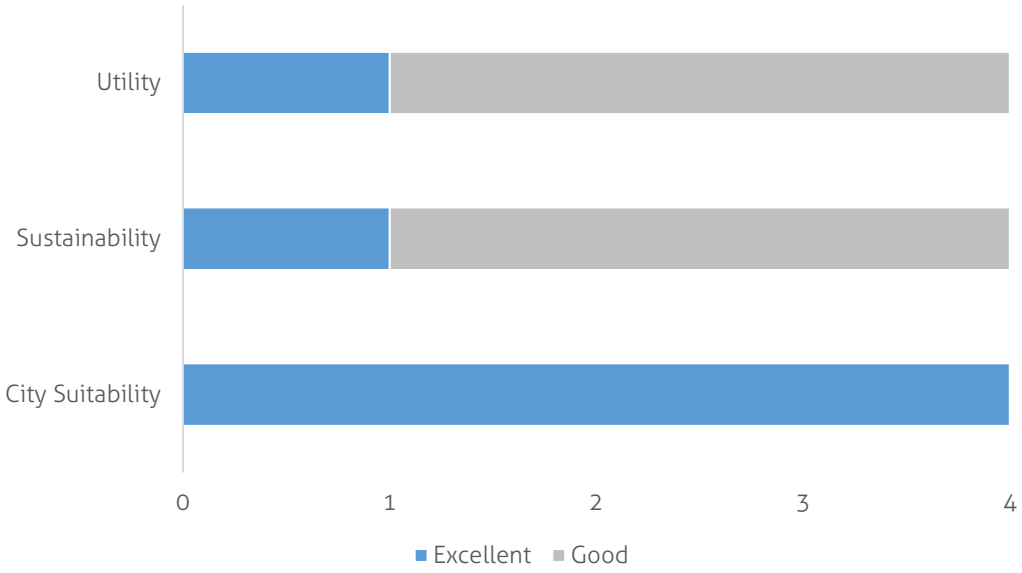
As a first step, they were asked to rate the concept in the following parameters, ranging from excellent to very poor. None of the participating experts answered below excellent or good.

Graph. 13: Evaluation of the product (own figure)



Furthermore, to all of them, this product appears to be a huge contribution to the city in comparison to other brands.

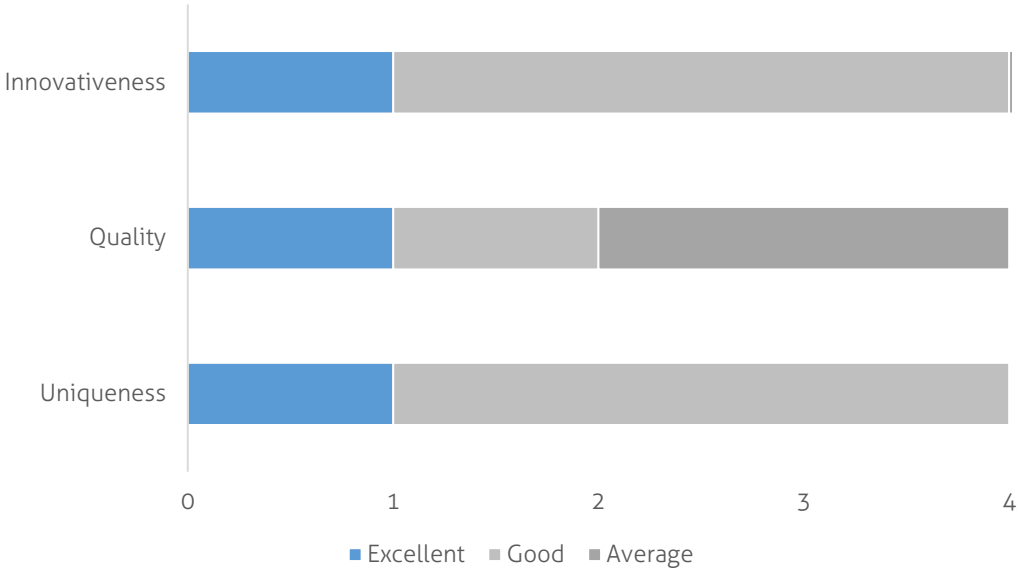
Another step within the framework of the product information, the experts have been asked to give their opinion to the technical specifications. The results can be seen in Graphic 14.



Graph. 14: Evaluation of the technical specifications (own figure)

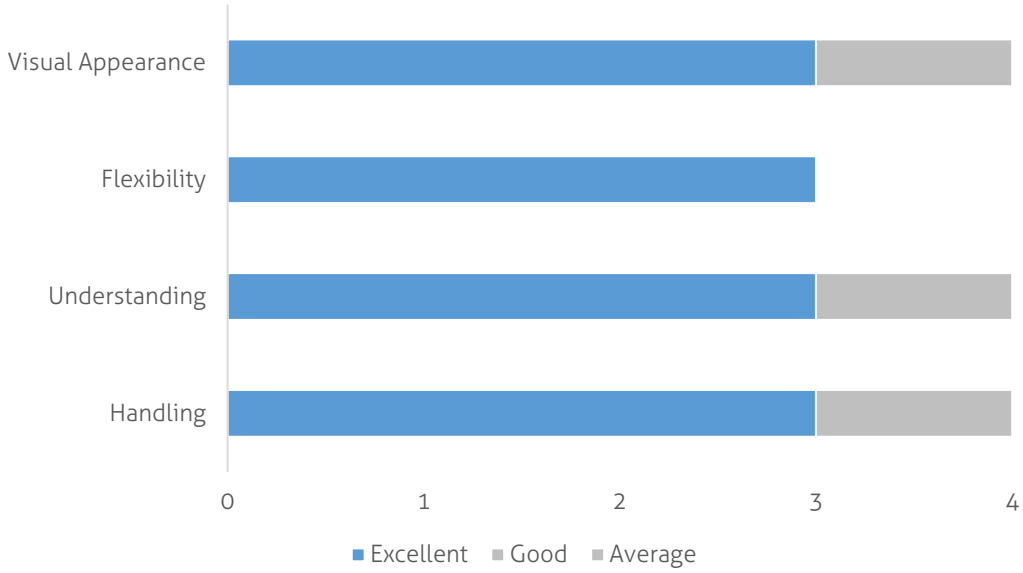
Service Specifications

In order to evaluate the service concept, the experts have been asked to range the service and in particular also the smartphone application in an international competition with similar brands available on the market.



Graph. 15: Evaluation of the service (own figure)

The smartphone application in competition to other brands was rated as followed:



Graph. 16: Evaluation of the smartphone application (own figure)

In summary, it can be ascertained that the product as well as the service concept seem to be a sustainable contribution to counteract the traffic related problems in Greater Lisbon.

23 Synthesis

Within the scope of chapter IV, the development and the final presentation of the car sharing concept was focused. In a first step, therefore, a wish list, adapted to the different customers' needs, was presented as a "road map" for further concept ideas and developments. Building on those achievements and wishes, three different concepts have been developed, in order to meet the predefined goals. Using a matrix evaluation, one of those concepts was chosen as the final concept to be developed within the scope of the dissertation.

During the further course of chapter IV, an extensive presentation of the final product and service concept was provided, including the vehicle interior and exterior concept, the description of the smartphone application and the user interface design for internal steering. In order to guarantee an appropriate final concept evaluation, a questionnaire was send to a selected panel of experts.

In general, it can be assumed that the concept has been evaluated very well, including only a few comments on the overall function of the service interacting with the product in use. Acceptable justifications have been implemented in the presentation of the concept within this chapter. Other recommendations, which require further extensive investigation will be presented within the chapter "Conclusions and Recommendations".

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Chapter V

Conclusions and Recommendation

25 Conclusions

Against the background of the challenges of the 21st century of ensuring positive aspects of mobility in conjunction with the negative effects of transport – greenhouse gases, air pollution and noise – a sustainable car sharing concept has been developed within the scope of this dissertation, in order to examine if the idea of a customer-oriented product-service system could be a sustainable solution to counteract the increasing traffic problems in Greater Lisbon.

First of all, the theoretical principles of sustainability, mobility and car sharing have been investigated in the forefront to provide a comprehensive basic knowledge and to ensure a perfect and smooth reconciliation to the further topics of market analysis and concept development. A concluding sustainability analysis of car sharing showed furthermore, that car sharing simultaneously contributes theoretically to all three dimensions of sustainability without emphasizing any in particular and that it is in fact able to deliver positive outcomes.

Following on from the theoretical contextualization, a comprehensive market study, including a competition analysis, a location analysis and a customer analysis, could provide information about the local market conditions and made a significantly contribution to the framework, necessary for the subsequent concept development. Especially the location analysis showed, that Lisbon offers a well-developed charging infrastructure, which can be used for an all-electric vehicle fleet. According to an online survey, conducted in the course of this dissertation, car sharing on the other hand is quite unknown among large sections of the population, in particular in the age group between 25-45 years. 68.7 % of the respondents were not aware of the concept of this product-service

system and needed to receive information and clarification, in order to assess whether car sharing could be accepted by the population in Lisbon. After an extensive explanation however, 59.4 % could imagine to use car sharing as an alternative transport solution, 32.7 % were unsure.

Based on various ideas, given by the interviewees, and the concepts, investigated beforehand, the final project development achieved a successful outcome of a tailored car sharing. The designed vehicle literally rounded off the previous work of this dissertation, with a clear and simple exterior design and a user-friendly, modern interface in the form of a smartphone application and a straightforward user interface integrated in a pleasant and comfortable interior design of the vehicle. The autonomously driven car provides space for two passengers and a panoramic view, in order to enjoy the beautiful places of Lisbon.

A panel of experts, composed of specialist in their fields of sustainability, vehicle development, battery electric vehicles and energy efficiency, finally assessed the concept and its technical specifications.

Conclusively, it can be said that car sharing and the here developed concept in particular, could lead to an improvement of the traffic related problems in Greater Lisbon. Not only due to the all-electric vehicle fleet, the use of car sharing can help to counteract the environmental and social issues caused by transport in the city. It should be borne in mind, however, that the idea of car sharing on the other hand needs to be spread further and the people living in Portugal need to experience more information about this sustainable traffic solution and its benefits. Furthermore, it needs to be mentioned that, in conjunction with a fully working car sharing service, the general public transport system needs to be improved to stimulate the use of this new alternative.

26 Recommendations for Further Investigations

As described beforehand in the conclusions, a panel of experts evaluated the final car sharing concept with the help of a written questionnaire. The resulting findings and recommendations have either been implemented directly in the product, service or presentation, or they are leading to recommendations for further investigations on the subject of car sharing in Greater Lisbon:

- **Utility improvement:** In combination with an inductive charging system, enabling the vehicles to share energy, an additional charging vehicle, especially designed for the purpose of recharging the car sharing cars on the ride, can be offered as a special service.
- **Inductive traffic-light charging:** The charging network, composed of Mobi.E charging stations, shall be extended to an inductive charging system. With the help of the principle of electromagnetic induction, cars can be recharged while waiting at the red traffic light.
- **Additional option of ride-sharing:** In addition to the traditional car sharing system, users will be able to also share a ride with other passengers, similar to bus and public transport.

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Appendix

Appendix 1: The United Nations sustainable development goals

Source: UN (2015)

Annexes

Annex 1: Sustainability Analysis car sharing fleet competitors

Sustainability Car Sharing Fleet

car2go number of vehicles			
Location	smart mhd	smart electric drive	smart petrol
Amsterdam		350	
Austin		8	375
Berlin	1200		
Brooklyn, N.Y.C			500
Calgary	650		
Columbus			200
Denver			50
Florenz	200		
Frankfurt	250		
Hamburg	700		
Madrid		350	
Mailand	700		
Montreal	450		
München	500		
Portland		10	500
Rheinland	600		
Rom	600		
San Diego		400	
Seattle			680
Stockholm			250
Stuttgart		500	
Toronto	425		
Turin	450		
Twin Cities			530
Vancouver	1250		
Washington D.C.			700
Wien	700		
Total	8675	1618	3785

14078

car2go g CO2/km			
	smart mhd	smart electric drive	smart petrol
per vehicle (mean value old and new models)	98	0	100
in total per vehicle category	850150	0	378500

mean fleet value per vehicle: 87,27447081 g CO2/km per vehicle

Souces: car2go, 2016, n.p.

Sustainability Car Sharing Fleet

CityDrive number of vehicles

Location	Opel Adam	Skoda Fabia	VW up	
Lisbon	20	10	10	
Total	20	10	10	40

CityDrive g CO2/km

	Opel Adam	Skoda Fabia	Skoda Fabia diesel	VW up
per vehicle (mean value old and new models)	115	108	88	105
in total per vehicle category	2300	980	1050	

mean fleet value per vehicle 108.25 g CO2/km per vehicle

Souces: João Coelho, 2016, n.p.
Opel, 2016, n.p.
Skoda, 2016, n.p.
Volkswagen, 2016, n.p.

Sustainability Car Sharing Fleet

DriveNow number of vehicles

Location	petrol / diesel	electric drive
Munich	415	85
Berlin	900	140
Düsseldorf	455	45
Köln		
Hamburg	460	70
Vienna	430	20
London	240	50
Kopenhagen		400
Stockholm	260	
Total	3160	810	3970

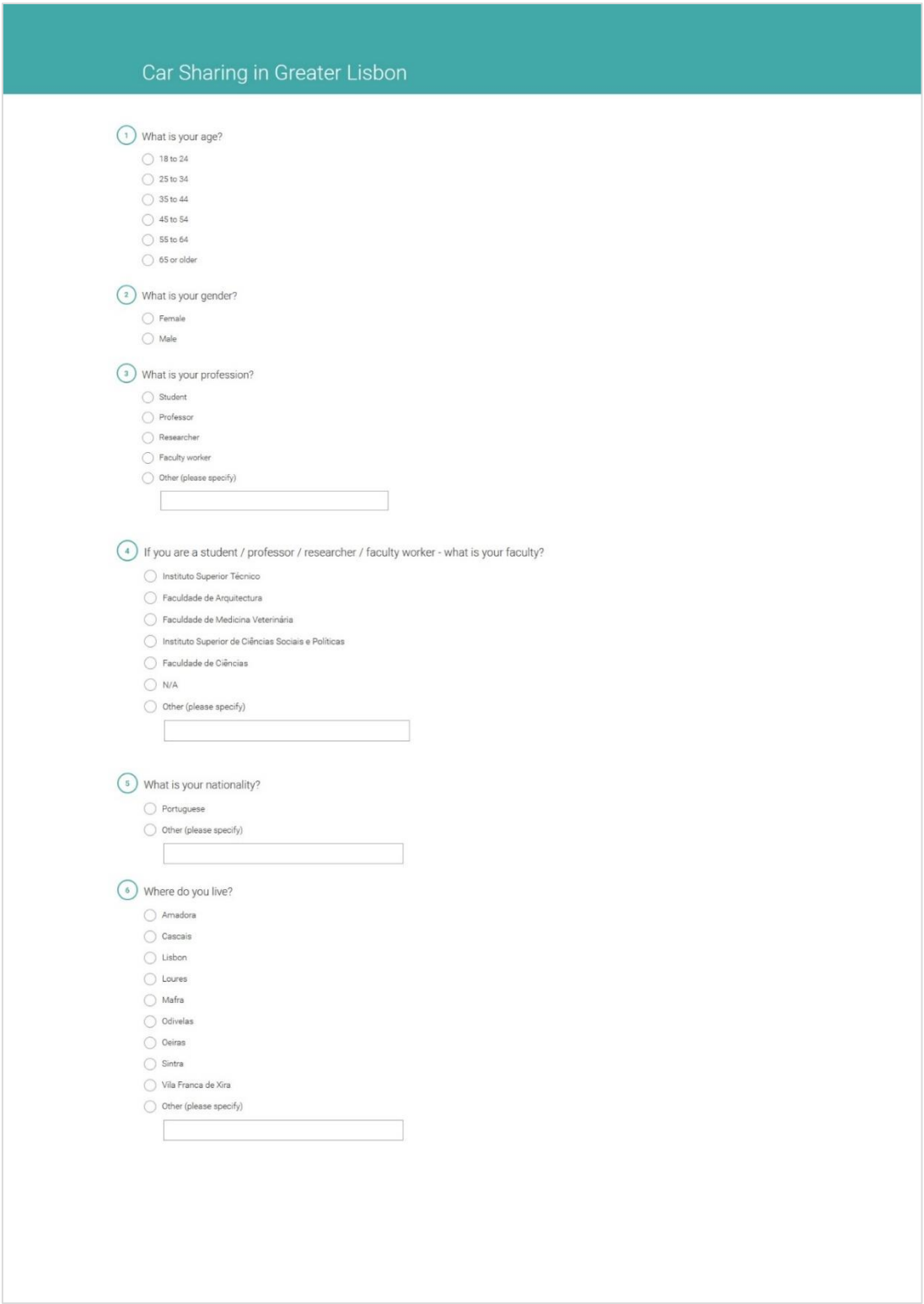
DriveNow g CO2/km

	BMW i3	BMW i3 Rex	BMW 1er	BMW X1	BMW 2er Active Tourer	BMW 2er	MINI Clubman	MINI 3-doors	MINI 5-doors	MINI Countryman	MINI Cabrio
per vehicle (mean value old and new models)	0	0	109	144	114	118	123	107	109	129	133
in total per vehicle category	381306.67	0									

mean fleet value per vehicle 96.04701931 g CO2/km per vehicle

Souces: BMW, 2016, n.p.

Annex 2: Online Survey Questionnaire



Car Sharing in Greater Lisbon

1. What is your age?
   - 18 to 24
   - 25 to 34
   - 35 to 44
   - 45 to 54
   - 55 to 64
   - 65 or older
2. What is your gender?
   - Female
   - Male
3. What is your profession?
   - Student
   - Professor
   - Researcher
   - Faculty worker
   - Other (please specify)
4. If you are a student / professor / researcher / faculty worker - what is your faculty?
   - Instituto Superior Técnico
   - Faculdade de Arquitectura
   - Faculdade de Medicina Veterinária
   - Instituto Superior de Ciências Sociais e Políticas
   - Faculdade de Ciências
   - N/A
   - Other (please specify)
5. What is your nationality?
   - Portuguese
   - Other (please specify)
6. Where do you live?
   - Amadora
   - Cascais
   - Lisbon
   - Loures
   - Mafra
   - Odivelas
   - Oeiras
   - Sintra
   - Vila Franca de Xira
   - Other (please specify)

7 Do you have a private car at your disposal?

- ◯ Yes, I possess a car
- ◯ Yes, I use a car available in my household
- ◯ No

8 How often do you use the car?

- ◯ Never use
- ◯ Slightly use
- ◯ Regularly use
- ◯ Daily use
- ◯ N/A

9 What do you use the car for?

	Never use	Slightly use	Regularly use	Daily use	N/A
To make trips to the grocery store	◯	◯	◯	◯	◯
To get to the university / workplace	◯	◯	◯	◯	◯
Visiting family that live elsewhere in the city / province	◯	◯	◯	◯	◯
Holiday trips	◯	◯	◯	◯	◯
Medical-related appointments	◯	◯	◯	◯	◯
Other trips	◯	◯	◯	◯	◯

10 What is the major share of trips you do by car?

- ◯ 1-person trips
- ◯ 2-person trips
- ◯ 3-person trips or more
- ◯ N/A

11 How long are the cars in your household driven on an average day?

- ◯ 0-10 min
- ◯ 11-20 min
- ◯ 21-30 min
- ◯ 31-40 min
- ◯ 41-50 min
- ◯ 51-60 min
- ◯ 61-70 min
- ◯ 71-80 min
- ◯ 81-90 min
- ◯ 91-100 min
- ◯ 101-110 min
- ◯ 111-120 min
- ◯ more than 2 hours
- ◯ N/A

12 Cars - what do you associate with them?

- ◯ Cars are status symbols, which reflect e.g. professional success or lifestyle
- ◯ Cars are only one, very convenient, type of transportation
- ◯ Other (please specify)

13 How often do you use the public transport system in Greater Lisbon?

- ◯ Never use
- ◯ Slightly use
- ◯ Regularly use
- ◯ Daily use

14 Please evaluate the public transport network in Greater Lisbon according to the following criteria?

	Very good	Good	Neutral	Bad	Very bad	N/A
Availability	◯	◯	◯	◯	◯	◯
Frequency	◯	◯	◯	◯	◯	◯
Price	◯	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯	◯
Sustainability	◯	◯	◯	◯	◯	◯

15 What is your understanding of Car Sharing?

- ◯ I give others a ride using my private car (e.g. BlaBlaCar)
- ◯ I can pick up a car at fixed stations in the city
- ◯ I have no idea

What Car Sharing is...

Car Sharing is a model of car rental where people rent vehicles for short periods of time, often by the hour. The users must go through a pre-qualification of ID and driving record and are then able to access the service's car autonomously whenever they want, using smartphones or smart cards. The usage is typically billed in time increments of minutes or hours.

The principle of carsharing is that individuals gain the benefits of private cars without the costs and responsibilities of ownership. The vehicles are usually available from distributed locations across a service area. The Car Sharing fleets may consist of electric or conventional vehicles.

The picture below illustrates a service station of the German Car Sharing operator car2go located in Berlin.

16 Could you imagine to use Car Sharing?

- ◯ Yes
- ◯ Not sure
- ◯ No (please specify)

17 How many times would you anticipate using Car Sharing?

- ◯ Once a month
- ◯ Twice a month
- ◯ Once a week
- ◯ Twice a week
- ◯ More than twice a week
- ◯ N/A

18 What would you typically use Car Sharing for?

	Never	Slightly	Regularly	Daily	N/A
To make trips to the grocery store	◯	◯	◯	◯	◯
To get to the university / workplace	◯	◯	◯	◯	◯
Visiting family that live elsewhere in the city/province	◯	◯	◯	◯	◯
Holiday trips	◯	◯	◯	◯	◯
Medical-related appointments	◯	◯	◯	◯	◯
Other trips	◯	◯	◯	◯	◯

19 Given you current budget, how much money would you anticipate spending on Car Sharing within a one month period?

- ◯ Less than 25€
- ◯ Around 25€
- ◯ Around 50€
- ◯ Around 75€
- ◯ Around 100€
- ◯ More than 100€

20 Car Sharing services are normally based on a smartphone application. Do you possess a smartphone with permanent internet access?

- ◯ Yes, I have a smartphone with permanent access to the internet
- ◯ Yes, I have a smartphone but my access to the internet is irregular (only at work, at home, public libraries, etc.)
- ◯ No, I don't possess a smartphone with internet access

21 What would be the longest amount of time you were willing to walk from your current position to a Car Sharing location in order to pick up a car?

- ◯ 1-5 minutes
- ◯ 5-10 minutes
- ◯ 10-15 minutes
- ◯ 15-30 minutes
- ◯ N/A

22 Why does Car Sharing appeal to you?

- [ ] It is a good alternative to allow you in the future to avoid replacing a (old) primary or secondary vehicle
- [ ] It is a good alternative to allow you to get rid of your vehicle
- [ ] It is a way to save money on transportation
- [ ] It helps to reduce inner-city traffic jams
- [ ] It is a way to reduce the air pollution in cities, especially if the fleet consists of electric vehicles
- [ ] It does not appeal to me
- [ ] Other (please specify)

23 Would a Car Sharing membership (instead of a private car) encourage you to increase the usage of more sustainable transport modes, such as public transport, walking and cycling?

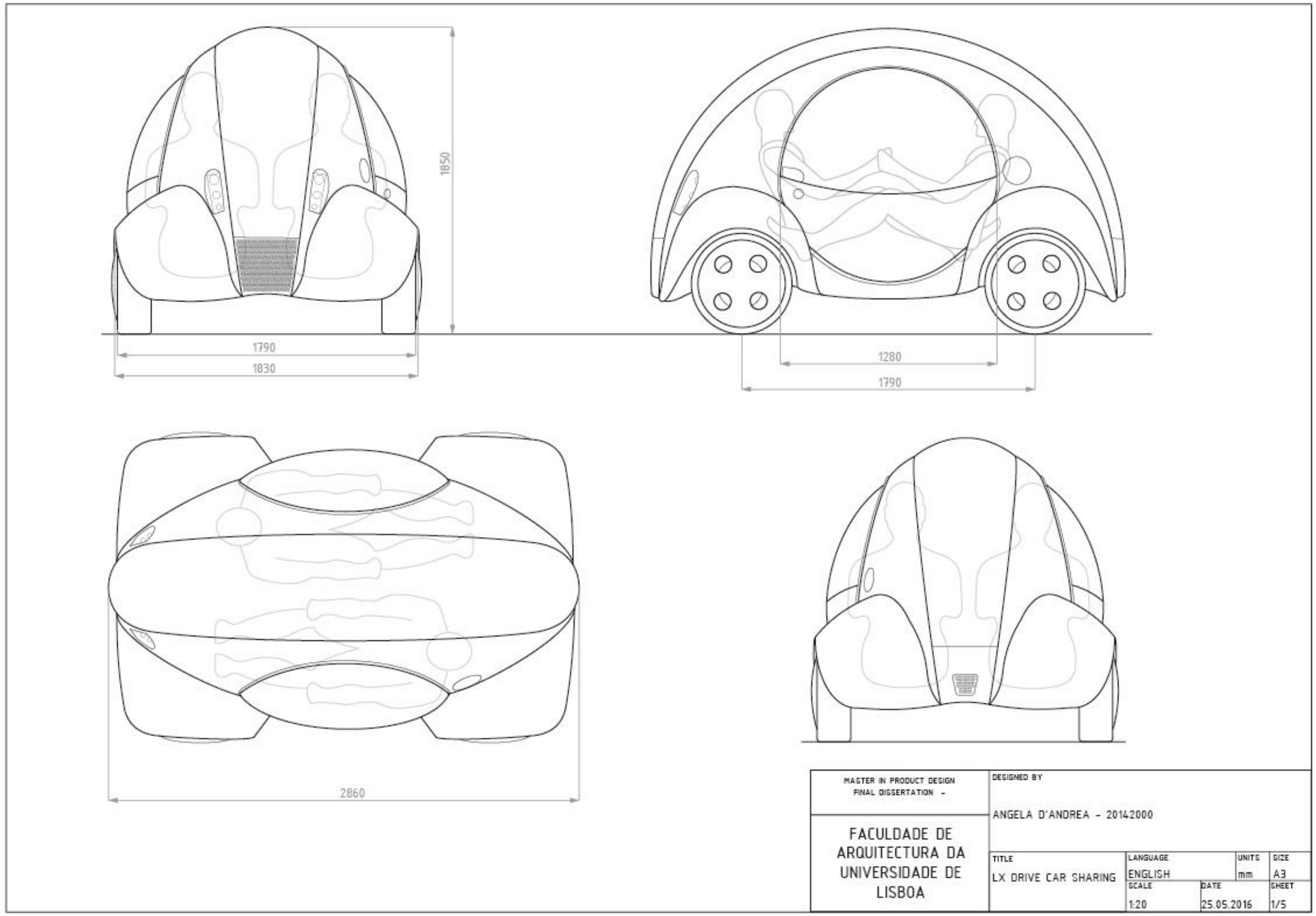
- ◯ Yes
- ◯ No
- ◯ N/A

24 What do you think might be the main disadvantages for you in Car Sharing?

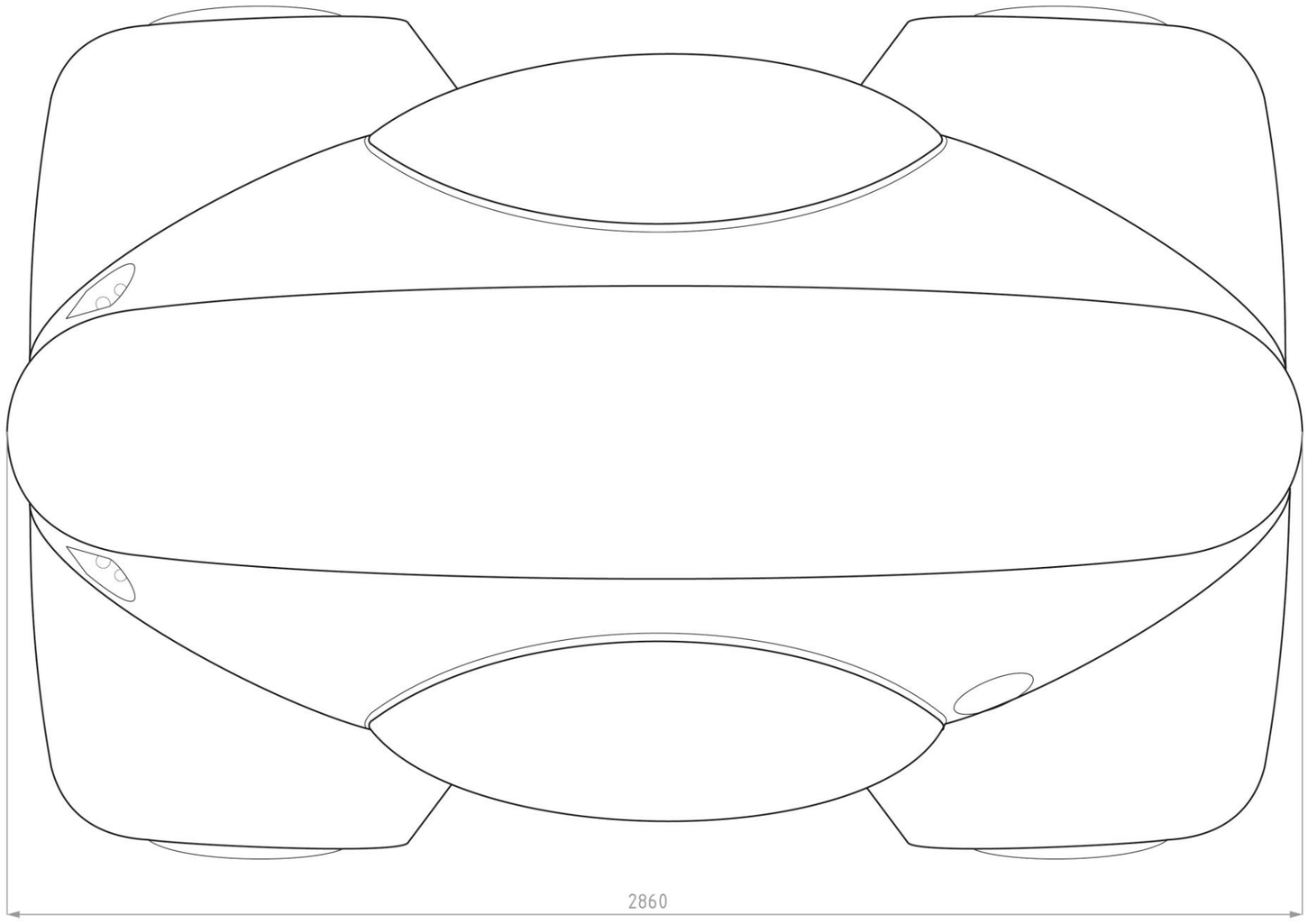
25 What should the perfect Car Sharing service / vehicle offer?

26 Be creative: What are your ideas about future mobility?

Annex 3: Technical Drawings



MASTER IN PRODUCT DESIGN FINAL DISSERTATION -	DESIGNED BY ANGELA D'ANDREA - 20142000
FACULDADE DE ARQUITECTURA DA UNIVERSIDADE DE LISBOA	TITLE: LX DRIVE CAR SHARING LANGUAGE: ENGLISH UNITS: mm SIZE: A3 SCALE: 1:20 DATE: 25.05.2016 SHEET: 1/5



MASTER IN PRODUCT DESIGN FINAL DISSERTATION	DESIGNED BY ANGELA D'ANDREA - 20142000			
FACULDADE DE ARQUITECTURA DA UNIVERSIDADE DE LISBOA	TITLE LX DRIVE CAR SHARING	LANGUAGE ENGLISH	UNITS mm	SIZE A3
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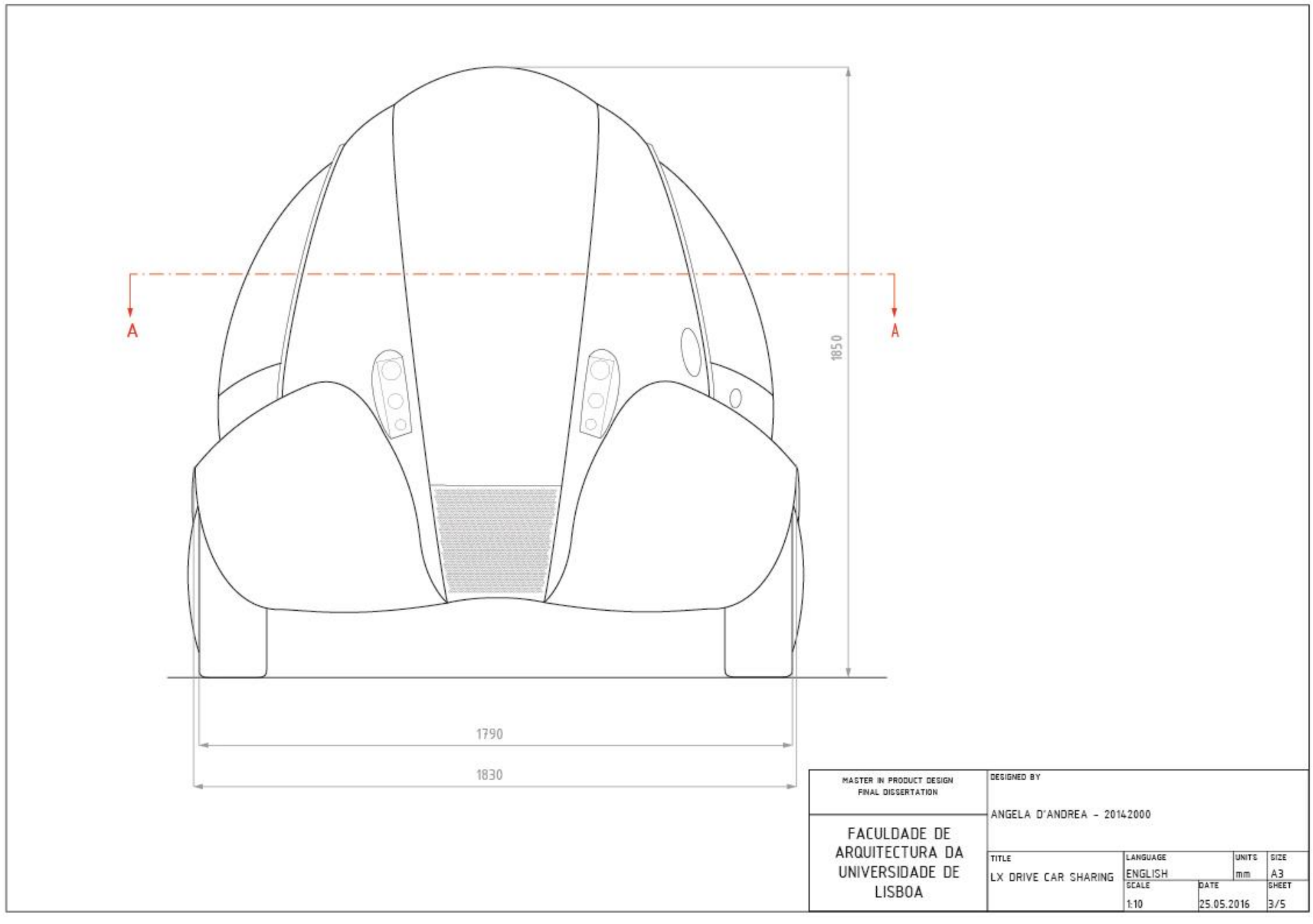

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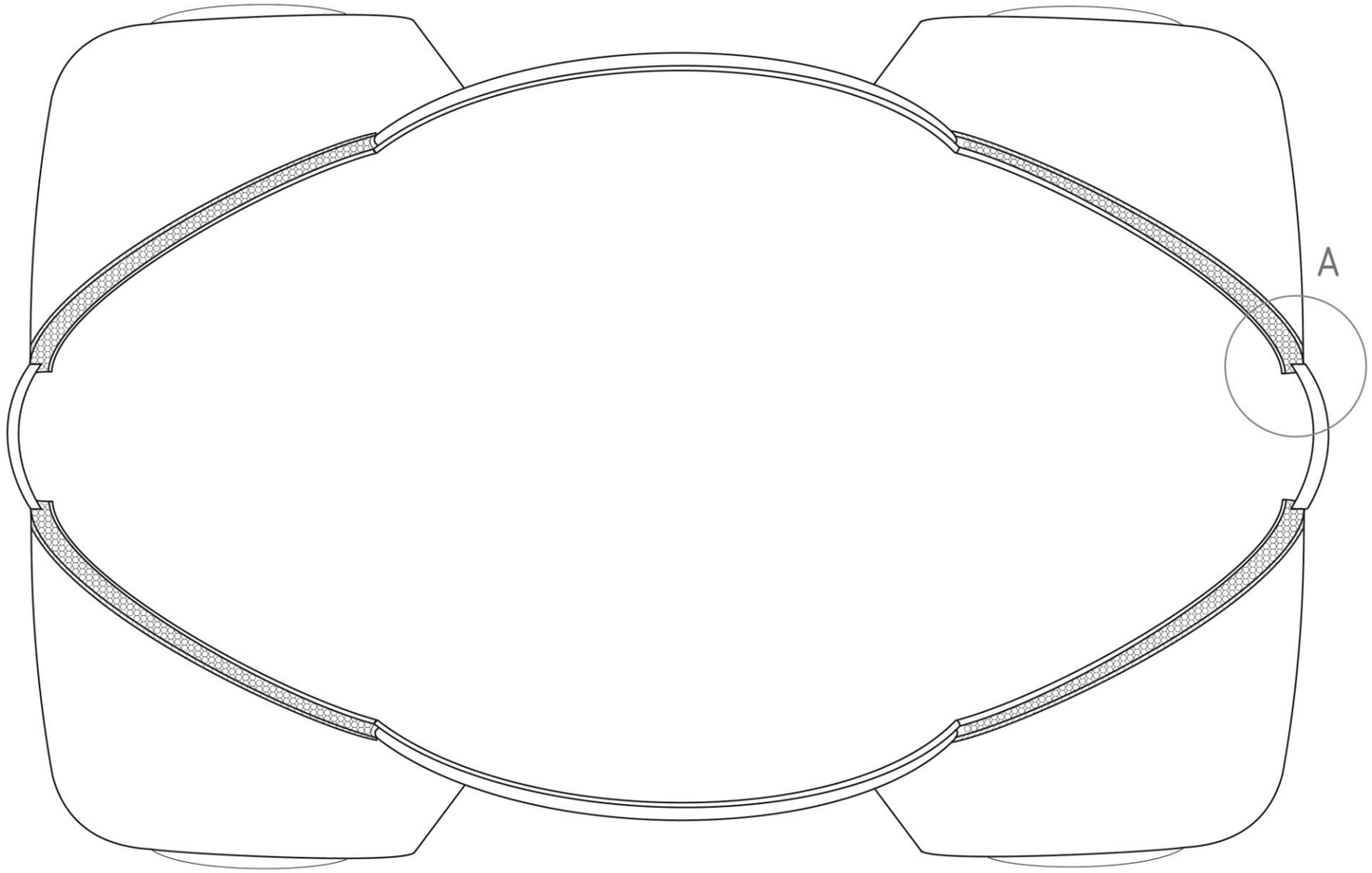
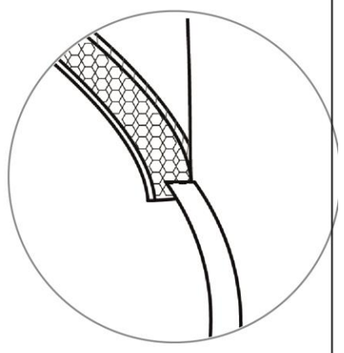
CUT A-A





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MASTER IN PRODUCT DESIGN FINAL DISSERTATION	DESIGNED BY ANGELA D'ANDREA - 20142000			
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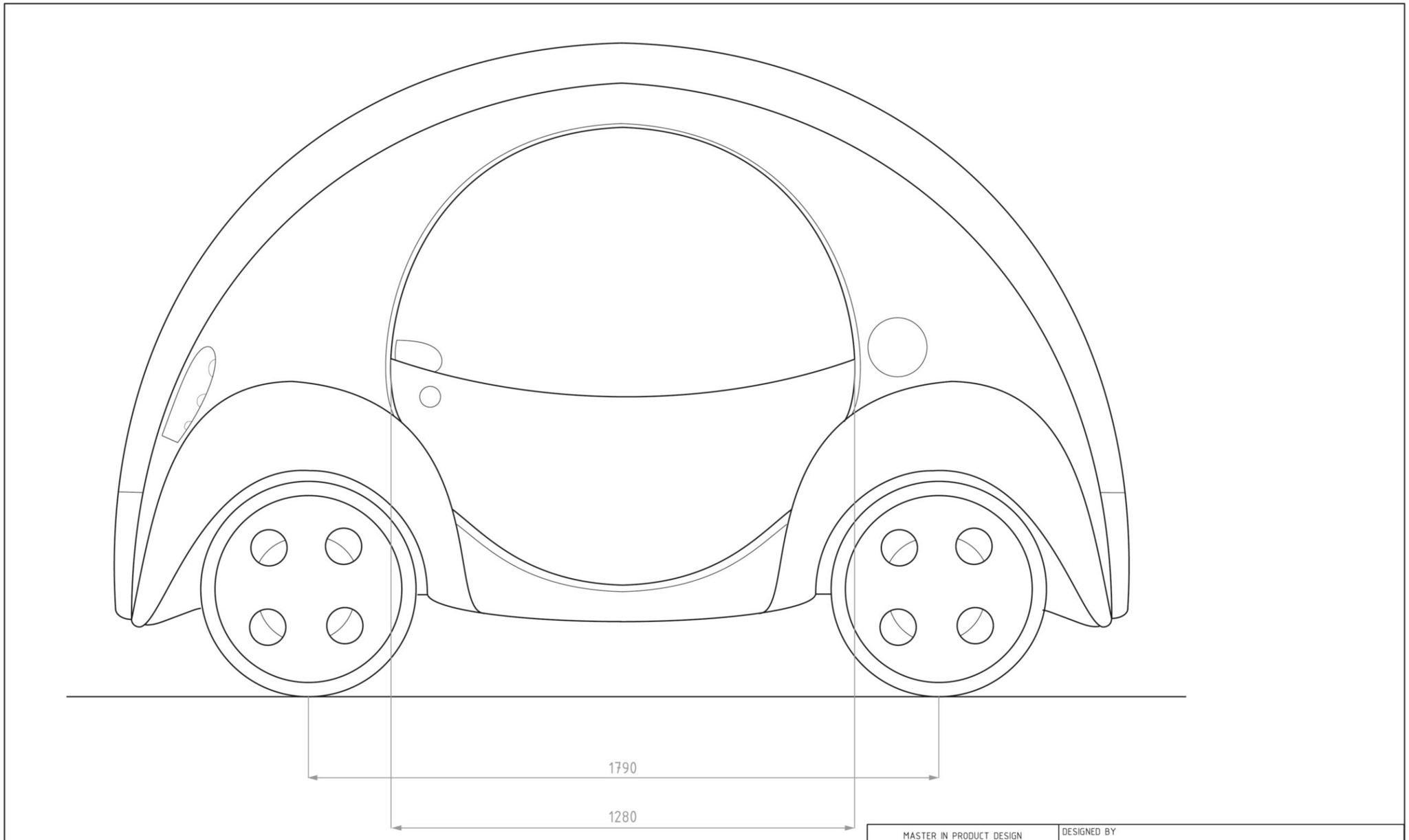

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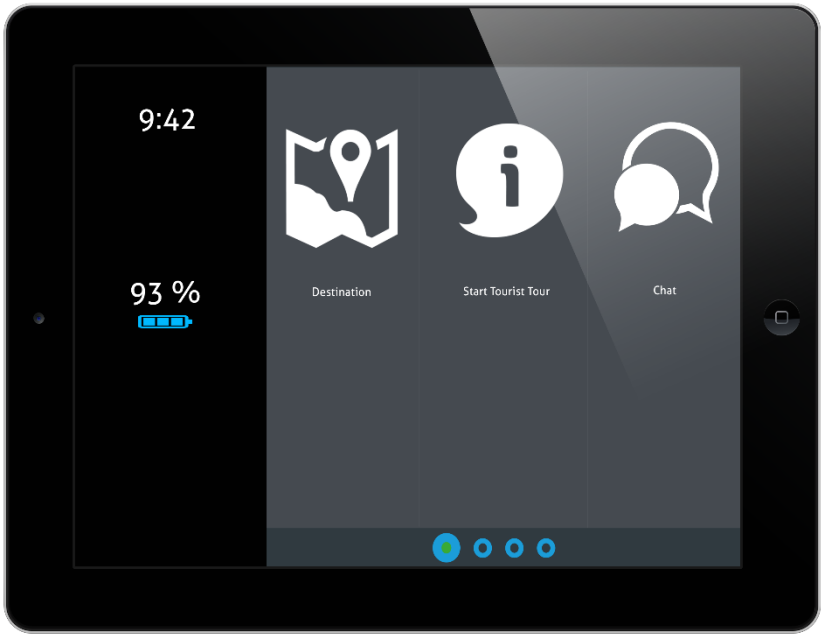
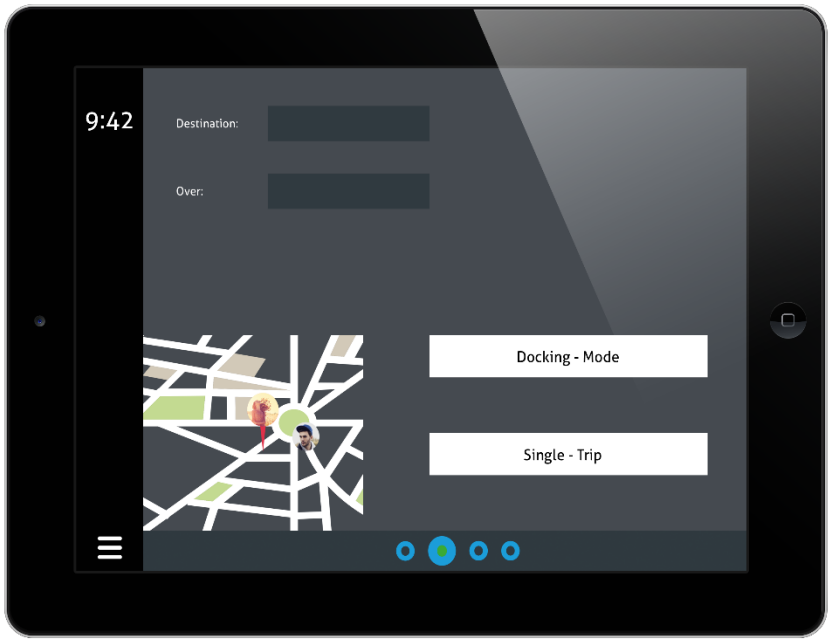
		SCALE 1:10	DATE 25.05.2016	SHEET 5/5

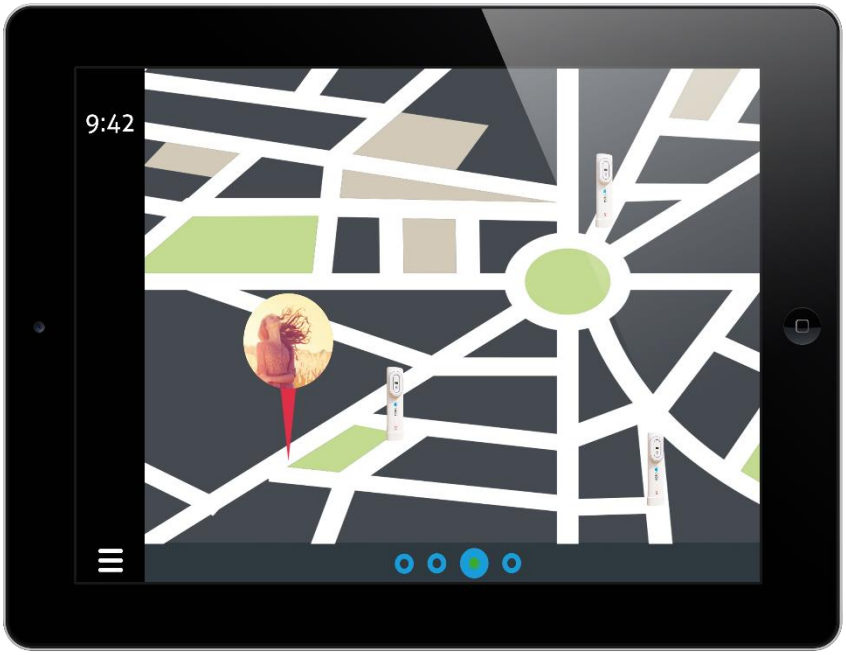
Annex 4: User Interface Interior



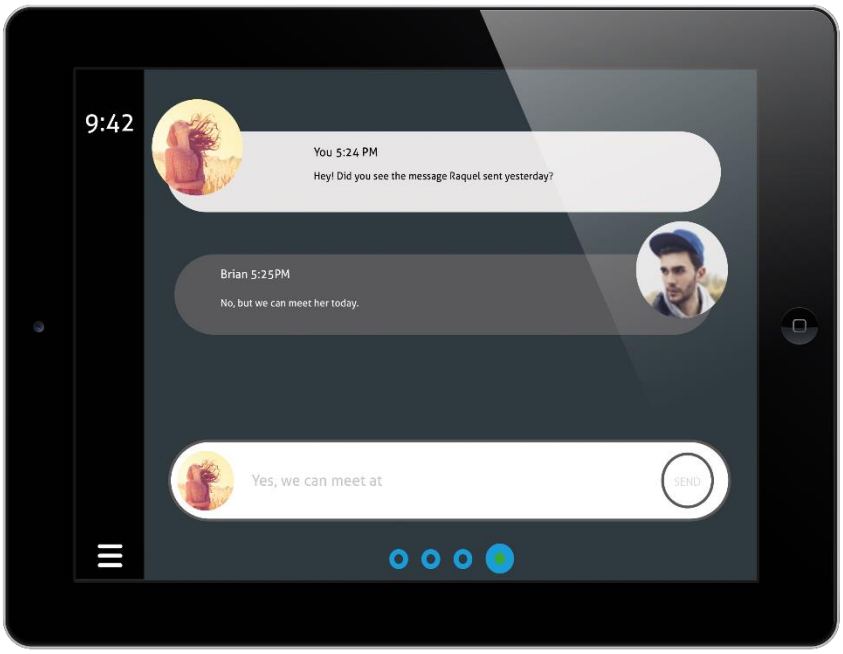
Menu – User Interface Interior



Destination – User Interface Interior



Map – User Interface Interior



Chat Mode – User Interface Interior

Annex 5: Questionnaire Panel of Experts

Angela D'Andrea

Master in Product Design
May 2016

QUESTIONNAIRE
CAR SHARING CONCEPT

IMAGINE A SHARED FUTURE

A Sustainable Car Sharing Concept for Greater Lisbon

INTRODUCTION

"One of the big challenges of the 21st century will be to mitigate the negative effects of transport – greenhouse gases, air pollution and noise – while ensuring positive aspects of mobility."

- Jacqueline McGlade, former executive director of the European Environment Agency (EEA) (2012) –

A growing size of the world's population and increasing prosperity in conjunction with the tendency towards urbanization led to an over-proportioned number of vehicles in cities and metropolitan areas all around the globe. Different circumstances such as the jumble of narrow streets, often found in Southern European countries, intensify the problems with road congestion and a lack of parking spaces.

The passenger transport in Portugal is nowadays predominantly characterized by passenger cars, which is owed to the constant availability and independence at predetermined times and routes. What from the user's perspective, however, represents the most convenient way of getting around, is accompanied by numerous negative environmental, economic and social side effects. Noise pollution, land use, traffic accidents, resource scarcity, air pollutant emissions and not least the emissions of harmful greenhouse gases are just some problems that result, for the most part, from the high traffic volume and are therefore contrary to the requirements of sustainable development.

To alleviate these negative effects, according to Jaqueline McGlade, more sustainable mobility concepts have to shift in the center of design and development nowadays. The property-less car use, the so-called car sharing could offer a highly promising approach while preserving the individual mobility.

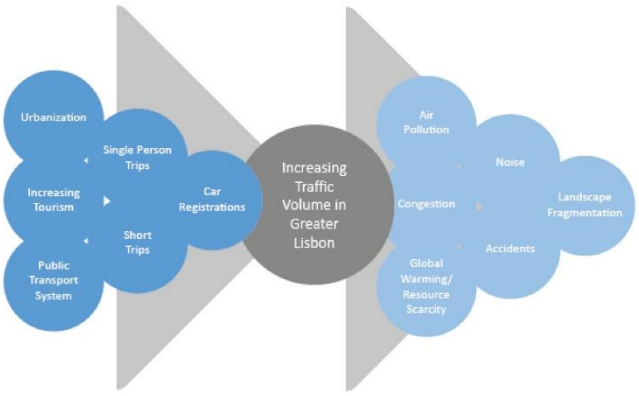
In this context and to contribute to an increasingly sustainable and innovative environment in Greater Lisbon, a sustainable car sharing concept was designed within the scope of a master's dissertation at University of Lisbon in the field of Product Design.

In order to evaluate the developed concept, you will find enclosed the following material:

- Description of the product and its technical specifications
- Description of the service including app-design
- Questionnaire to evaluate the product-service concept

Thank you very much for your time.

PROBLEMS



Lisbon is the capital city of the coastal nation Portugal, situated in the southwestern of this European country and agglomeration area with a population density of 115 inhabitants per km². The population of Greater Lisbon slightly enlarged from 2,042,326 in 2001 to 1,947,261 in 2011 and comprises about 20% of Portugal's entire population. Lisbon is daily facing an immense volume of road traffic, which rose by 60% between 1991 and 2001, causing many traffic related problems for the city and its inhabitants.

Lisbon's public transport system is comprised by metro, buses and tram, consisting of only 4 separated metro lines. One of the most touristic hotspots is only connected by one tram and buses which leads to overloads in rush hours (AMTL, 2014, n.p.). Moreover, there has been a strong surge in car registrations in Portugal from 1973 to 2004. Whereas the car registrations in 1973 accounted 710,000, the value rose to 5,996,000 in 2004, which reflects the cultural importance of individual mobility in Portugal (European Commission, 2006, n.p.).

According to Weckström-Eno (1999) "the Portuguese and Spanish persons are the least mobile ones" in Europe, with predominantly short distance travels. In this context, passenger cars are the most often chosen transport mode, with 10,132 billion passenger-kilometers per year.

Due to the concentration of employment in the center of the city, Lisbon is facing high amounts of commuting traffic through a small number of highways every day. These highways distribute the traffic to a small set of narrow roads which is limited expandable by reason of the hilly landscape.

Effects of this high amount of traffic are long. A short survey about noise disturbance and health impacts in Lisbon showed that "people living or studying/working in the municipality of Lisbon are the ones who complained most about road traffic noise", whereby 38 % of interviewee are sanitarily affected by the noise in an intermediate grade. This includes, among others, stress, anxiety and headaches (Quercus, 2013, n.p.). Another negative consequence of the increasing transport is the high number of traffic victims, injured or killed each year. Lisbon represents the region with the highest amount of accidents caused by road traffic in Portugal with 21 % in 2010 (INE, 2011, n.p.).

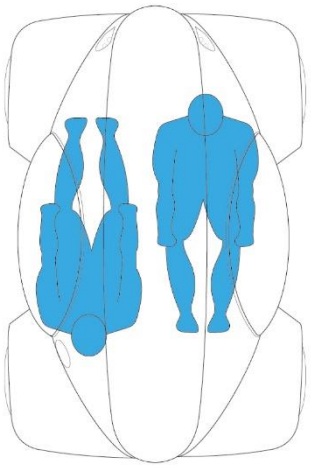
Lisbon experienced only slight reductions in the PM10 level between 2008 and 2012 (traffic station Avenida da Liberdade). The EU target of 35 days per year for exceeding the PM10 limit values has not been complied in 2008 (82 days) and in 2012 (79 days). 2014 was the first year Lisbon seemed to meet the EU target, but only due to meteorological conditions. NO2 limits were also breached in 2014 and this trend will continue in 2015 (BUND, 2014, n.p.).

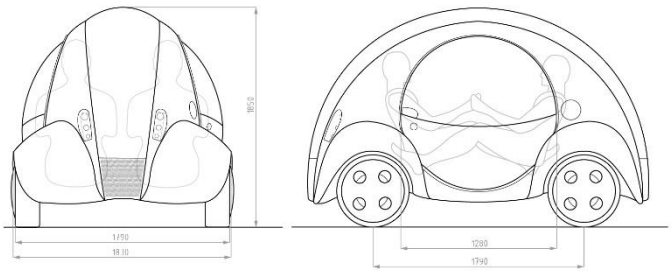
PRODUCT
VEHICLE CONCEPT

The vehicle concept for LX DRIVE was kept as simple as possible. Based on an online survey conducted wihtin the framwork of the project, indicating that the major share of rides with an own car is 1 - 2 person trips, the car only has two seats.

The vehicle drives autonomously, thus the seats can be turned and passengers are allowed to sit opposite each other.

According to the survey respondents, a small car is desired - easy to handle, easy to park. Therefore the vehicle has a length of 2,860 mm in total. It is electrically driven, using 30 kW in-wheel engines in each wheel.





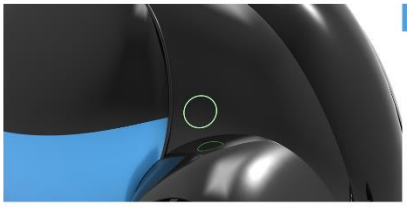
PRODUCT
TECHNICAL SPECIFICATIONS

The idea of simplicity is also reflected in the interior design, comprising two seats and a centre console. The windscreen allows an all-round view during the ride.

The centre console includes a touch-pad, providing a map and vehicle information, as well as a joystick in order to drive the car manually if necessary.

MAGNETIC DOCKING SYSTEM

The magnetic docking system allows several vehicles to connect each other while driving. During the docking process the vehicles are able to charge one another.



RANGE COLOUR SYSTEM

A light indicator integrated in the charging socket shows the battery status, ranging from green (fully charged) to red (minimum range).

90° STEERING ANGLE

90° all-wheel steering allows sidewards driving for easy parking.

SERVICE
SERVICE STRATEGY

SERVICE AREA

The serivce is based on a free-floating system. The main service area is devided into two service zones within the region of Greater Lisbon:

green zone: vehicles are available in this area. They can be rented and driven in these districts; the rent can be ended either at one of the charging stations of Mobi.E or they can be parked anywhere within the green zone (Mobi.E, 2016, n.p.).

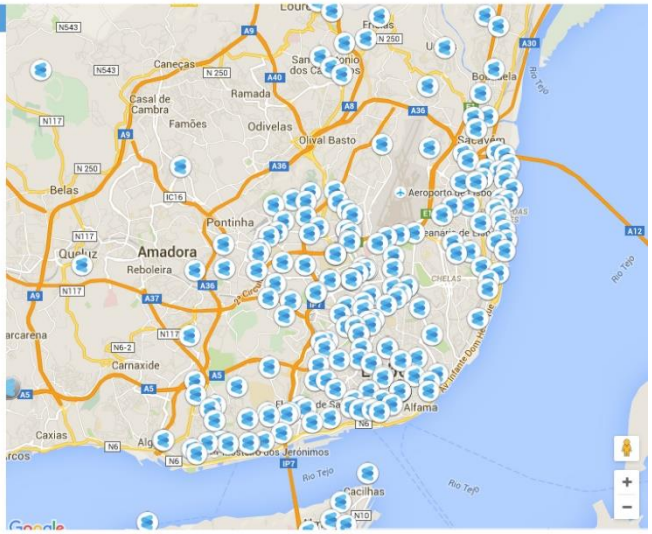
grey zone: the cars can be driven and parked in this area, the rent however cannot be ended here

CHARGING INFRASTRUCUTRE

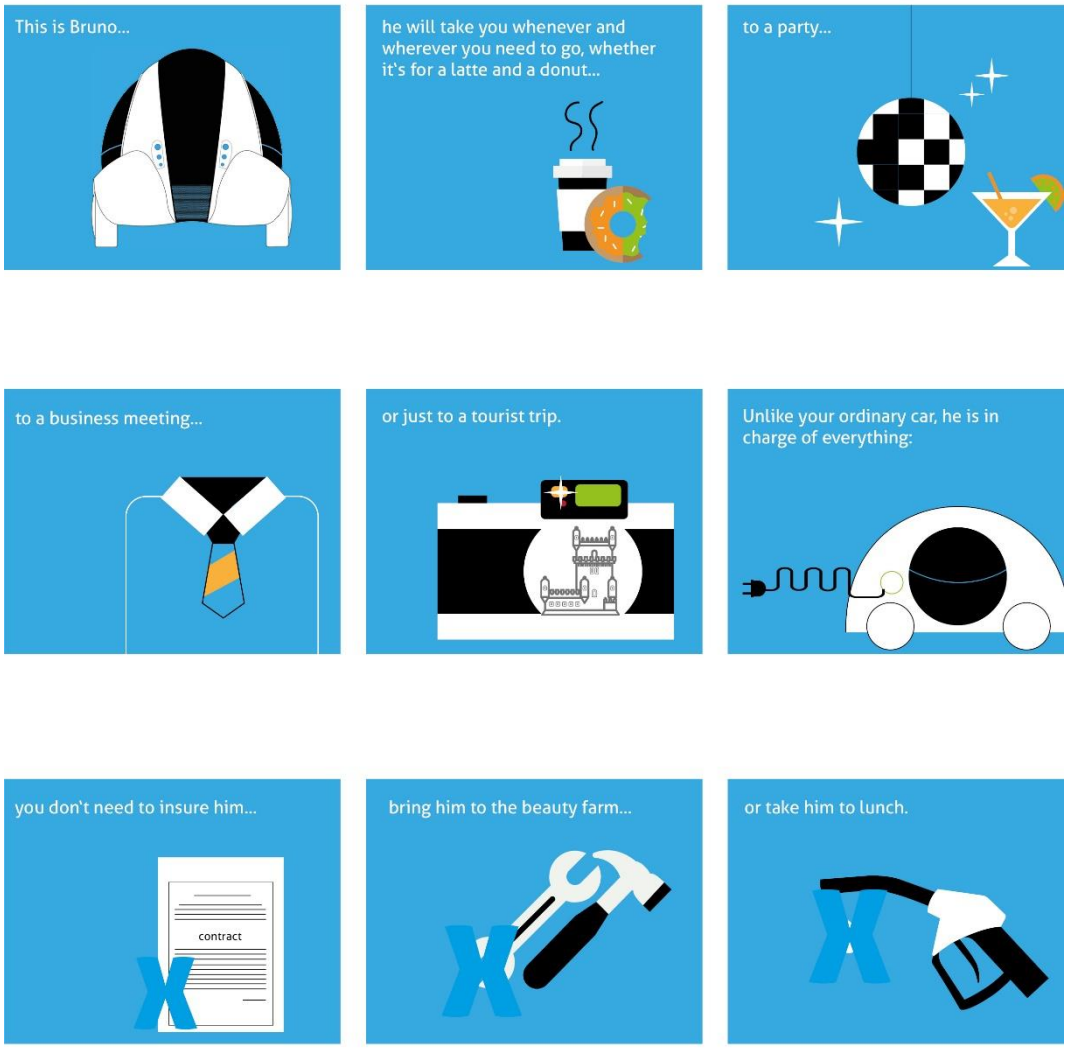
Mobi.E is a portuguese business model for a network of charging stations for electric vehicles. It includes 441 charging points in Portugal with a very high concentration in the Lisbon area.

This broad charging infrastructure can be used for the car sharing service of LXDrive, for loading and parking the vehicles for free.

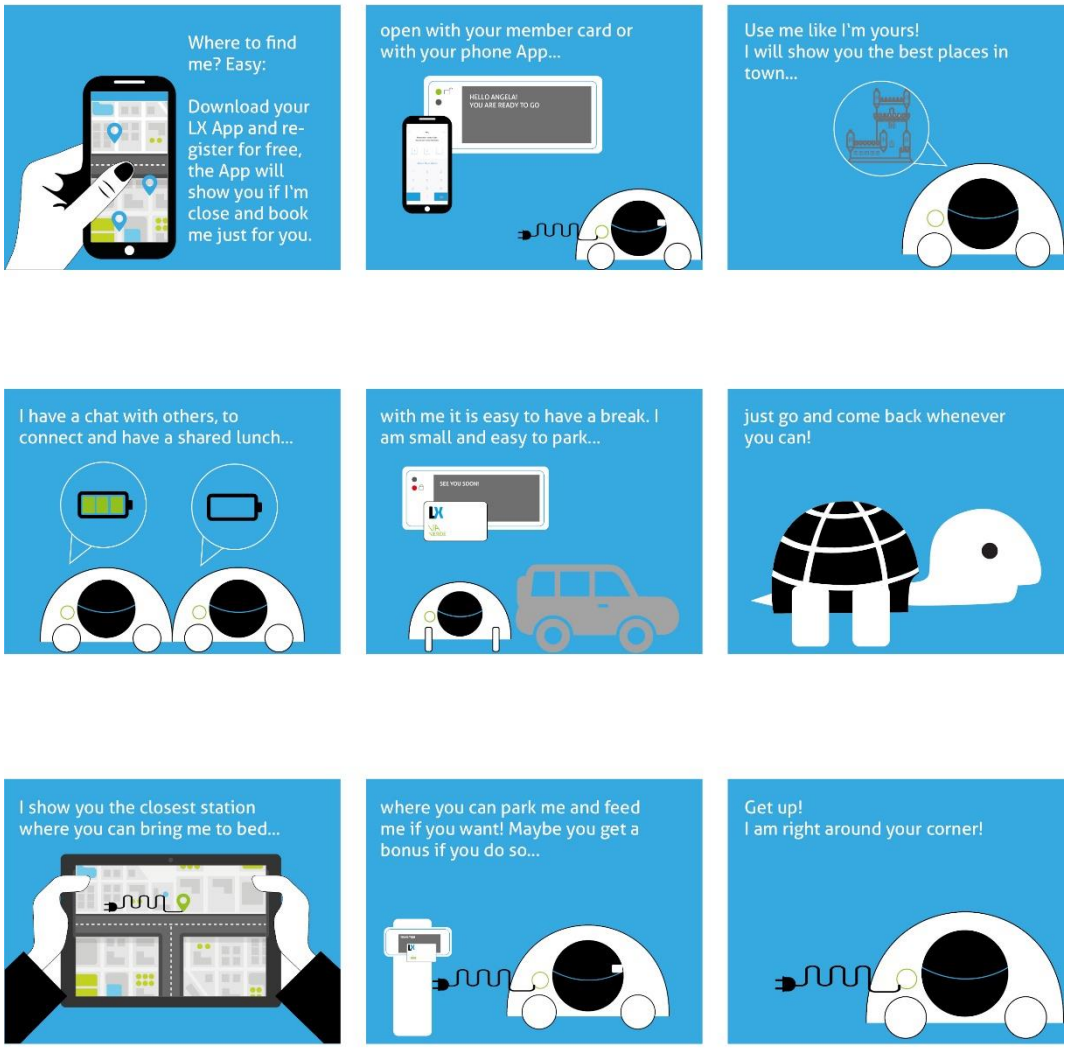
The user can plug in the vehicles at these stations, enabling him to receive bonus minutes for future rides. Vehicles can also be picked up or ordered from these stations. quaranteeing full state of charge.



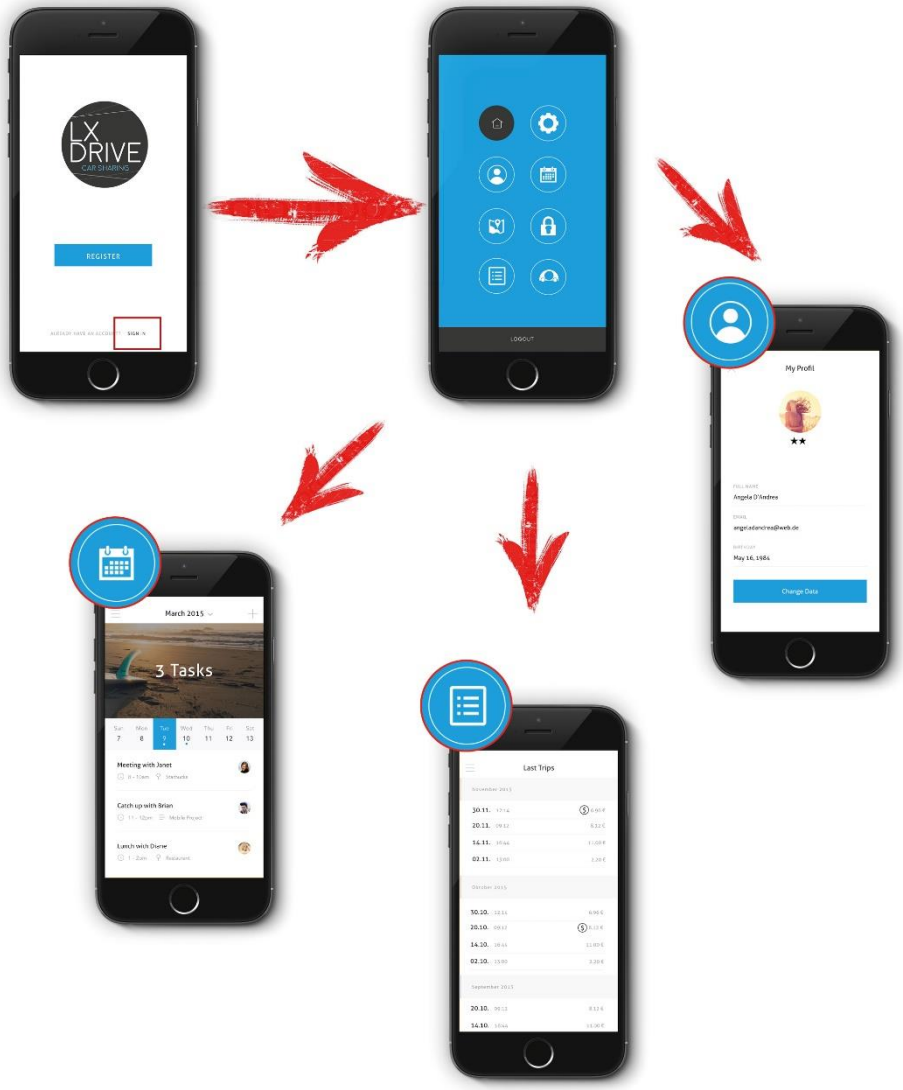
STORYBOARD


This is Bruno...
he will take you whenever and wherever you need to go, whether it's for a latte and a donut...
to a party...
to a business meeting...
or just to a tourist trip.
Unlike your ordinary car, he is in charge of everything:
you don't need to insure him...
contract
bring him to the beauty farm...
or take him to lunch.

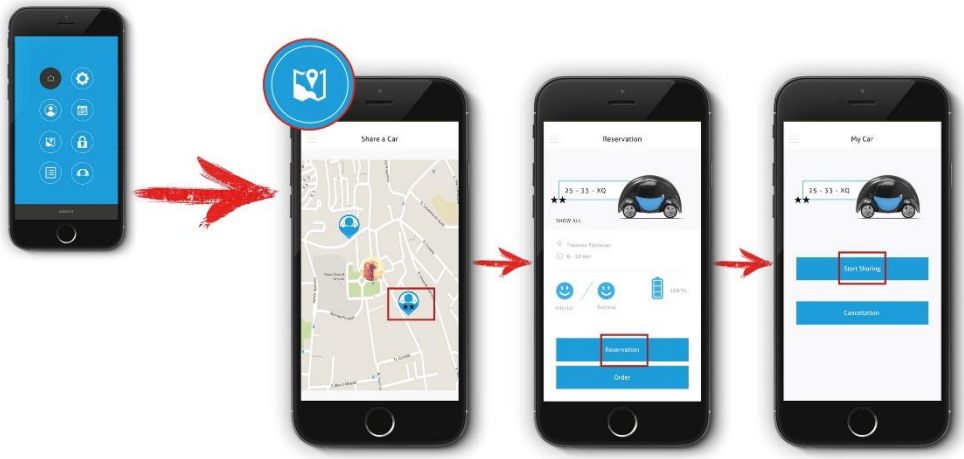
STORYBOARD


Where to find me? Easy:
Download your LX App and register for free, the App will show you if I'm close and book me just for you.
open with your member card or with your phone App...
HELLO ANGELA!
YOU ARE READY TO GO
Use me like I'm yours!
I will show you the best places in town...
I have a chat with others, to connect and have a shared lunch...
with me it is easy to have a break. I am small and easy to park...
SEE YOU SOON!
just go and come back whenever you can!
I show you the closest station where you can bring me to bed...
where you can park me and feed me if you want! Maybe you get a bonus if you do so...
Get up!
I am right around your corner!

SERVICE
SMARTPHONE APPLICATION

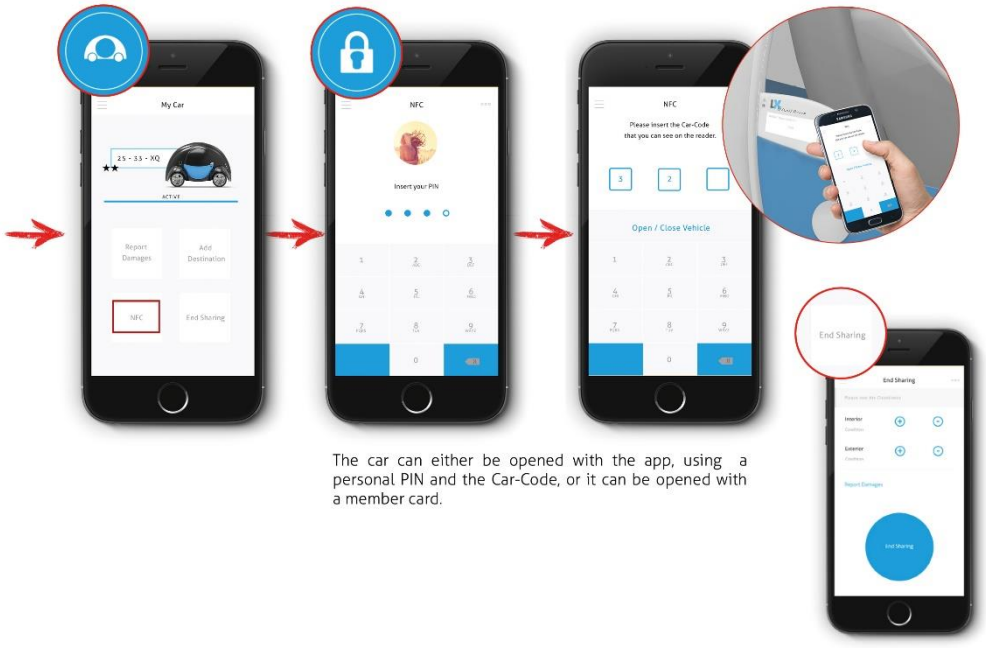


SERVICE
SMARTPHONE APPLICATION



The app can show you every car in the neighbourhood around the current location.

A vehicle with two stars is ready to be ordered to pick up the customer at his location. Reservation can be done, if the customer walks to the car on himself.



The car can either be opened with the app, using a personal PIN and the Car-Code, or it can be opened with a member card.

Annex 6: Answers Panel of Experts

QUESTIONNAIRE

1 - What organisation you work for?

Daimler

2 - What is your expertise?

Ingenieur

3 - Based on the description of the PRODUCT concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	☐	☒	☐	☐	☐
Quality	☐	☒	☐	☐	☐
Innovativeness	☒	☐	☐	☐	☐
Visual appearance	☒	☐	☐	☐	☐

4 - How do you think this PRODUCT compares with other brands available in the market in terms of meeting the local conditions?

☐ There doesn't appear to be any significant difference between this one and other brands.

☒ This product appears to be a huge contribution to the city in comparison to other brands.

5 - Based on the description of the technical specifications, how would you rate the PRODUCT concept on the following aspects?

	Excellent	Good	Average	Poor	Very poor
City Suitability	X				
Sustainability		X			
Utility		X			

6 - Which of the features of the PRODUCT do you like / do you not like? What could be an improvement?

(+) · Autonomes Fahren
· 90° Einparken
· Fahrzeuge verbinden

(-) · Da es ein Elektrofzg. ist, muss es aufgeladen werden. Das Bild der Infrastruktur zeigt, dass es aber ein Stadtauto ist.
Frage: · Wieviel km ist die Reichweite? Wo ist das Batteriekonzept? (Package + Größe)
· Für Fahrten zu entfernteren Zielen ist es glaub nicht geeignet. Für die Stadt sind ∑ 120kW aber zu viel.

- Wieso braucht man konventionelle Ladestationen zum einstecken? → Berührungsloses Laden mit kapazitiven Flächen im Boden
- Da das Fzg. selbst fahren kann. Sollte es nicht auch abholen können u. selbstständig zum laden fahren.

7 - Based on the description of the SERVICE concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	☐	☒	☐	☐	☐
Quality	☒	☐	☐	☐	☐
Innovativeness	☐	☒	☐	☐	☐

8 - How do you think this smartphone application compares with other brands available in the market regarding the follwing parameters?

	Excellent	Good	Average	Poor	Very poor
Handling	☒	☐	☐	☐	☐
Understanding	☒	☐	☐	☐	☐
Flexibiliy	☒	☐	☐	☐	☐
Visual appearance	☒	☐	☐	☐	☐

9 - This PRODUCT AND SERVICE concept, accoring to you...?

☐ does not fit the local conditions and needs considerable modifcations.

☒ can be a sustainable contribution to counteract the traffic related problems.

10 - Which of the features of the SERVICE do you like / do you not like? What could be an improvement?

(+) - Anpassung an meinen Kalender.
↳ Es fährt allerdings die Besichtigung ob dann auch ein Fzg. mit abholt?

(−) - gibt es im Auto ein Sprachassistent?
z.B. wie "Siri"

Fragen: - Wie wird 30°C Einparken mit Radnabenmotoren realisiert?
- Batteriegröße?
- große Motorleistung! Wie schnell fährt es?
- Was ist mit Kofferraum?
- ~~Kann man in Notsituation selber fahren?~~

QUESTIONNAIRE

1 - What organisation you work for?

Daimler AG - Mercedes Benz Cars

2 - What is your expertise?

Development - Fuel efficiency - Battery electric and hybrid vehicles

3 - Based on the description of the PRODUCT concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	✓				
Quality		✓			
Innovativeness	✓				
Visual appearance		✓			

4 - How do you think this PRODUCT compares with other brands available in the market in terms of meeting the local conditions?

- ☐ There doesn't appear to be any significant difference between this one and other brands.
- ☐ This product appears to be a huge contribution to the city in comparison to other brands.

5 - Based on the description of the technical specifications, how would you rate the PRODUCT concept on the following aspects?

	Excellent	Good	Average	Poor	Very poor
City Suitability	✓				
Sustainability		✓			
Utility		✓			

6 - Which of the features of the PRODUCT do you like / do you not like? What could be an improvement?

The 90° all-wheel steering is a great feature, specially in cities like Lisbon with only few space for parking.
Autonomous driving is also a very cute function, as long as it can recognize humans crossing also in thin streets. The possibility of taking the manual option anytime gives the user a feeling of freedom, which can be decisive for convincing conservative users.

The infotainment should be described with high accuracy, since the handling of the car (opening doors, chosing the destination, taking over for manual) should be very intuitive.

It would be very interesting to know, which is the system and the logic behind the docking of the vehicles to eachother

Proposal for new function: ride-sharing (two users want to go to the same destination and share the same vehicle)

7 - Based on the description of the SERVICE concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	☐	☑	☐	☐	☐
Quality	☐	☐	☑	☐	☐
Innovativeness	☐	☑	☐	☐	☐

8 - How do you think this smartphone application compares with other brands available in the market regarding the follwing parameters?

	Excellent	Good	Average	Poor	Very poor
Handling	☐	☐	☑	☐	☐
Understanding	☐	☐	☑	☐	☐
Flexibiliy	☐	☐	☐	☐	☐
Visual appearance	☐	☑	☐	☐	☐

9 - This PRODUCT AND SERVICE concept, accoring to you...?

- ☐ does not fit the local conditions and needs considerable modifcations.
- ☑ can be a sustainable contribution to counteract the traffic related problems.

10 - Which of the features of the SERVICE do you like / do you not like? What could be an improvement?

Although there is only few explanations to the different services, the main function should be to make a reservation of one car for a trip. This seems to be quite easy with the app.

Further functions (list of last trips, user profile, ...) are ok, but not special.

Some otherr innovative functions like "sharing a ride" with somebody else or socializing/connecting with other users could be added to the App.

1 - What organisation you work for?

Daimler AG

2 - What is your expertise?

Mechanical engineering, energy loss analysis in vehicles, project manager

3 - Based on the description of the PRODUCT concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	☐	☑	☐	☐	☐
Quality	☑	☐	☐	☐	☐
Innovativeness	☑	☐	☐	☐	☐
Visual appearance	☑	☐	☐	☐	☐

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5 - Based on the description of the technical specifications, how would you rate the PRODUCT concept on the following aspects?

	Excellent	Good	Average	Poor	Very poor
City Suitability	✓				
Sustainability		✓			
Utility		✓			

6 - Which of the features of the PRODUCT do you like / do you not like? What could be an improvement?

Like: Concept fits in my expectations of future mobility! Concept brings good innovations and uses existing infrastucture

Questions: Can I place my shopping items in the trunk of the vehicle? Is there any trunk? If so, how much will fit in?
Can I use a baby seat?

Utility improvements: If charge-while-you-drive feature with magnetic connection plus autonomously driving there could be a luxury-service by sending a specially designed charging vehicle to connect to you car to do the charging on the go! The charging-vehicle could charge a whole row of magnetic connected cars while driving. In that way I won't lose any distance of the vehicle I'm using by charging others...

Different Idea: Why not have inductive charging at traffic-lights?

7 - Based on the description of the SERVICE concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	☐	☑	☐	☐	☐
Quality	☐	☐	☑	☐	☐
Innovativeness	☐	☑	☐	☐	☐

8 - How do you think this smartphone application compares with other brands available in the market regarding the follwing parameters?

	Excellent	Good	Average	Poor	Very poor
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- ☐ does not fit the local conditions and needs considerable modifcations.
- ☑ can be a sustainable contribution to counteract the traffic related problems.

10 - Which of the features of the SERVICE do you like / do you not like? What could be an improvement?

How about a calendar integration where I can schedule the vehicle to show up at defined places to pick me up or even pick my kids up to bring them to soccer training etc.? In that way I can seamlessly integrate your service in my daily life...

Since it's autonomous: why do I have to bring the car to the charging station? I think I should do it by itself! And I don't want to go and pick the car up... the car should be able to pick ME up!

I think in terms of SERVICE todays products could go way beyond just the idea of shared cars. With the ability of autonomouly driving complete new service strategies can be found that customers really want to have.

This leads somewhere else, but these questions are on my mind by thinking about your concept:
In the autonomous driving world: Do I still need a car on my own? How could the service look like, if I want to travel with my family to the seaside in the south of Portugal? Can't mobility not just be an all-inclusive-service?
In that future: Can not-so-wealthy people afford mobility? What is the price of these services? Will mobility be more expensive than today?

QUESTIONNAIRE

1 - What organisation you work for?

European Commission

2 - What is your expertise?

Senior Manager

3 - Based on the description of the PRODUCT concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	✓				
Quality		✓			
Innovativeness	✓				
Visual appearance	✓				

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- [x] This product appears to be a huge contribution to the city in comparison to other brands.

5 - Based on the description of the technical specifications, how would you rate the PRODUCT concept on the following aspects?

	Excellent	Good	Average	Poor	Very poor
City Suitability	✓				
Sustainability	✓				
Utility	✓				

6 - Which of the features of the PRODUCT do you like / do you not like? What could be an improvement?

I like the flexibility of this product as well as the design and geometry

7 - Based on the description of the SERVICE concept, how would you rate it on the following parameters?

	Excellent	Good	Average	Poor	Very poor
Uniqueness	✓				
Quality		✓			
Innovativeness	✓				

8 - How do you think this smartphone application compares with other brands available in the market regarding the follwing parameters?

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- ☑ can be a sustainable contribution to counteract the traffic related problems.

10 - Which of the features of the SERVICE do you like / do you not like? What could be an improvement?

I like the flexibility of the smart phone application